MINING CONGRESS JOURNAL

JULY 1959

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MAXIMUM SERVICE...

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carbide-tipped **bits**

Job-proven to give you *more* . . . in production, performance and service! In "show-down" tests in mine after mine, Cardox bits maintain a lower "cost-per-foot cut or drilled" rating than any other. It's no secret why . . . Cardox carbides are job-matched to meet your specific mining requirements, whether it be drilling or cutting. They are made to uniform quality standards . . . bit after bit, they deliver the same consistently high production output, the same long service life. They make continuous mining more continuous. Want proof? We'll be glad to run a test at your mine. You name the time, place and conditions. Bits available in all sizes and styles.

and

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immediate service

lasting satisfaction

You can rely on Airdox-Cardox for straight practical answers to your mining problems. We offer you a unique combination of experience, know-how, broadest distribution and stocking facilities, and available qualified underground personnel to answer your needs efficiently, effectively and economically. Call on us . . . where there's coal, there's . . . AIRDOX-CARDOX!

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VOL. 45 July 1959 NO. 7

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Opinions expressed by the authors within these pages are their own and do not necessarily represent those of the American Mining Congress.

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ON OUR COVER

The newest Kolbe Wheel Excavator, a 150-ft high, 2100-ton machine, working at Cuba, Ill., can dig 3500 cu yd of overburden per hour and convey it 420 ft to the spoil bank. For complete story see page 67.

Published Monthly. Yearly subscriptions, United States, Canada, Central and South America, $3.00. Foreign, $10.00. Single copies, $0.75. February Annual Review Issue, $1.25. Second class postage paid at Washington, D. C., and at additional Post Office, Lancaster, Pennsylvania.

A MAJOR BREAKTHROUGH IN FINE COAL CLEANING

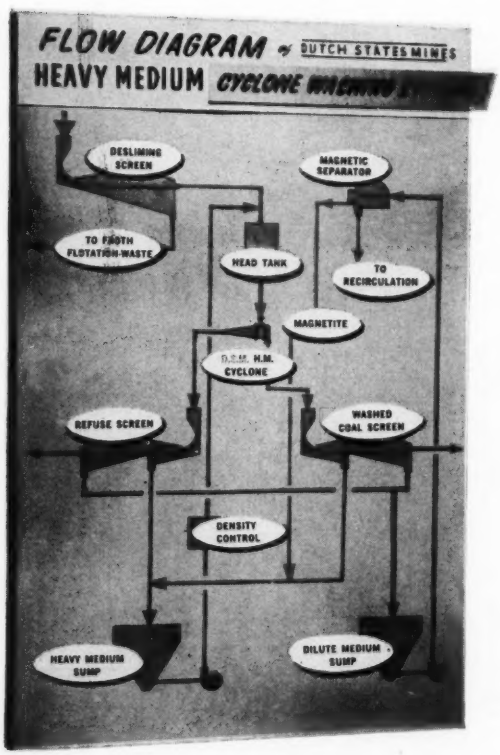
The Dutch State Mines

HEAVY MEDIUM CYCLONE WASHER

for fine coal, ¾ inch to 48 mesh

Did you see the Hit of the Show?

Cleans coal cleaner with lower ash and higher Btu at any specific gravity you want . . . greater recovery than with any other cleaning system regardless of size distribution, particle shape or percentage of near gravity material.



The completely new heavy medium cyclone washing system is now, for the first time, available to coal producers in the United States—and *exclusively through Roberts & Schaefer.*

With positive control and laboratory efficiency on a production scale, you can increase recovery of fine coal and deliver a better quality product to your customers.

You can make an effective separation anywhere in the specific gravity scale and produce the quality coal your market demands.

Whether you are planning a new plant or are interested in the possibilities of improving the quality of your fine coal output, it will be worth your while to get the pertinent facts about the revolutionary heavy medium cyclone washing system.

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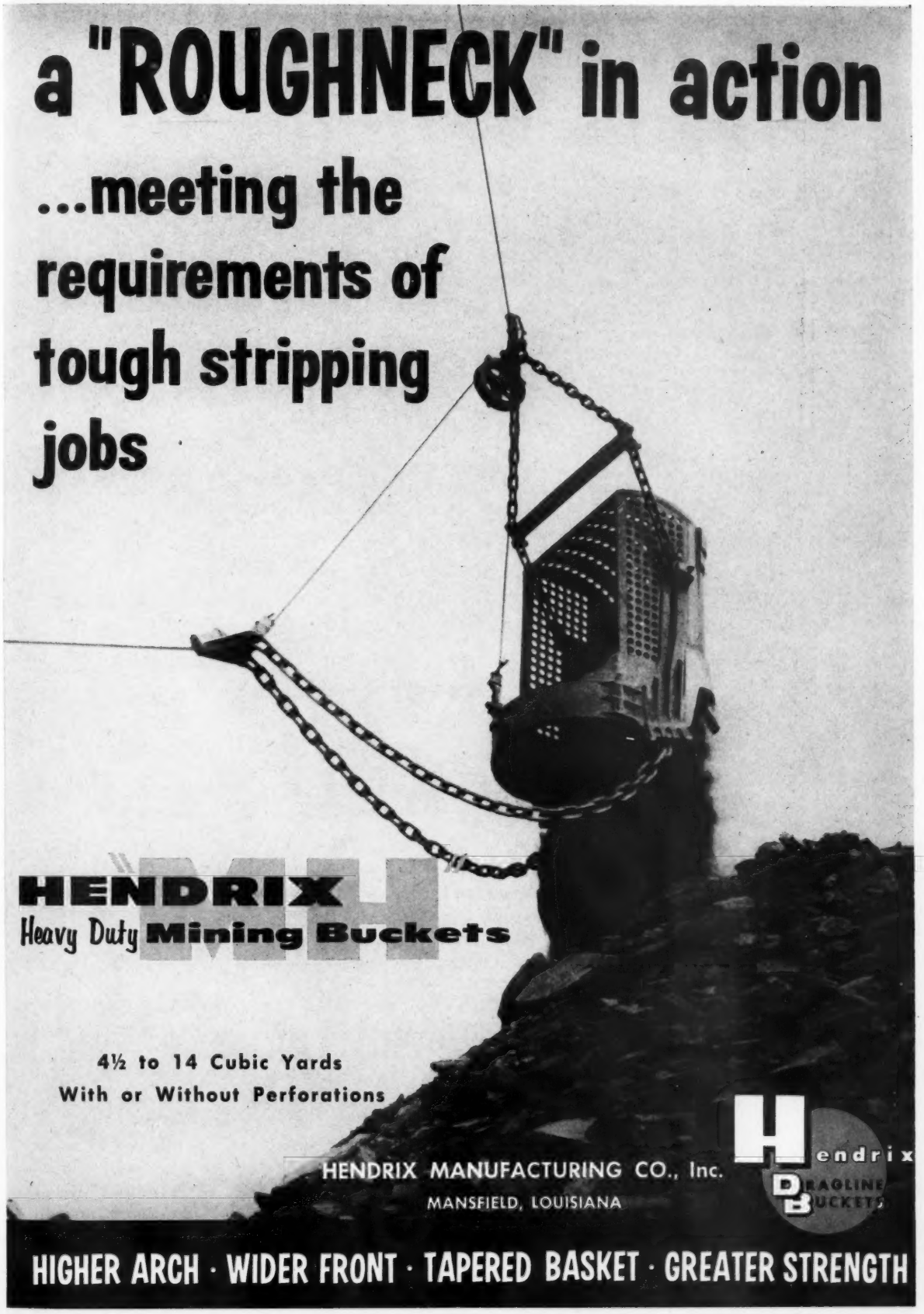
...meeting the requirements of tough stripping jobs



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Heavy Duty **Mining Buckets**

4½ to 14 Cubic Yards
With or Without Perforations

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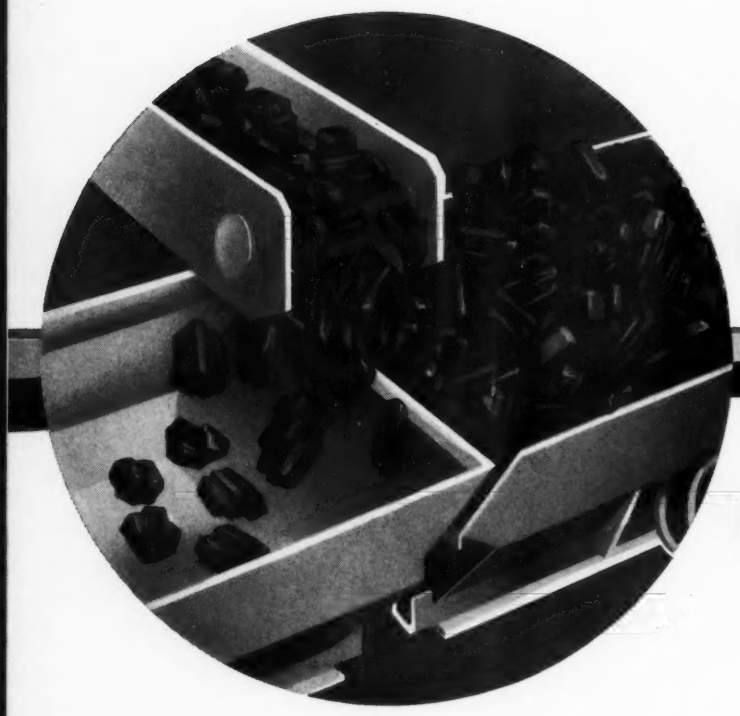

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Sevens pay off on the Iron Range, too, especially when made by a Marion 151-M.

This 7-yard machine continues to strengthen its reputation for steady, low-cost, dependable loading.

Here is stamina for the heaviest, hardest digging, with smooth, fast cycle time. Here is Ward-Leonard electric control with refinements that save on power costs and protect the machinery against shock and overload.

Let Marion mining specialists tell you about the work records being made in mining by the 151-M, and outline what it can do for you.

You get **MORE** *with* **MARION**

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When you splice and reinsulate with Uskorona® and re-jacket with "D.R." splicing compound, you renew the life of the cable. *The entire splice will last as long as the cable.*

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Uskorona exceeds A.S.T.M. specifications and can handle a wide range of electrical and general purpose jobs in mines. A complete line of mine tapes is available.

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USKORONA SPLICING TAPE

ABOVE GROUND. When spliced with Uskorona and "D.R." tapes, cables become perfect again. These splices restore the mechanical and dielectric quality of the cable, resist severe abrasion and exposure to moisture.

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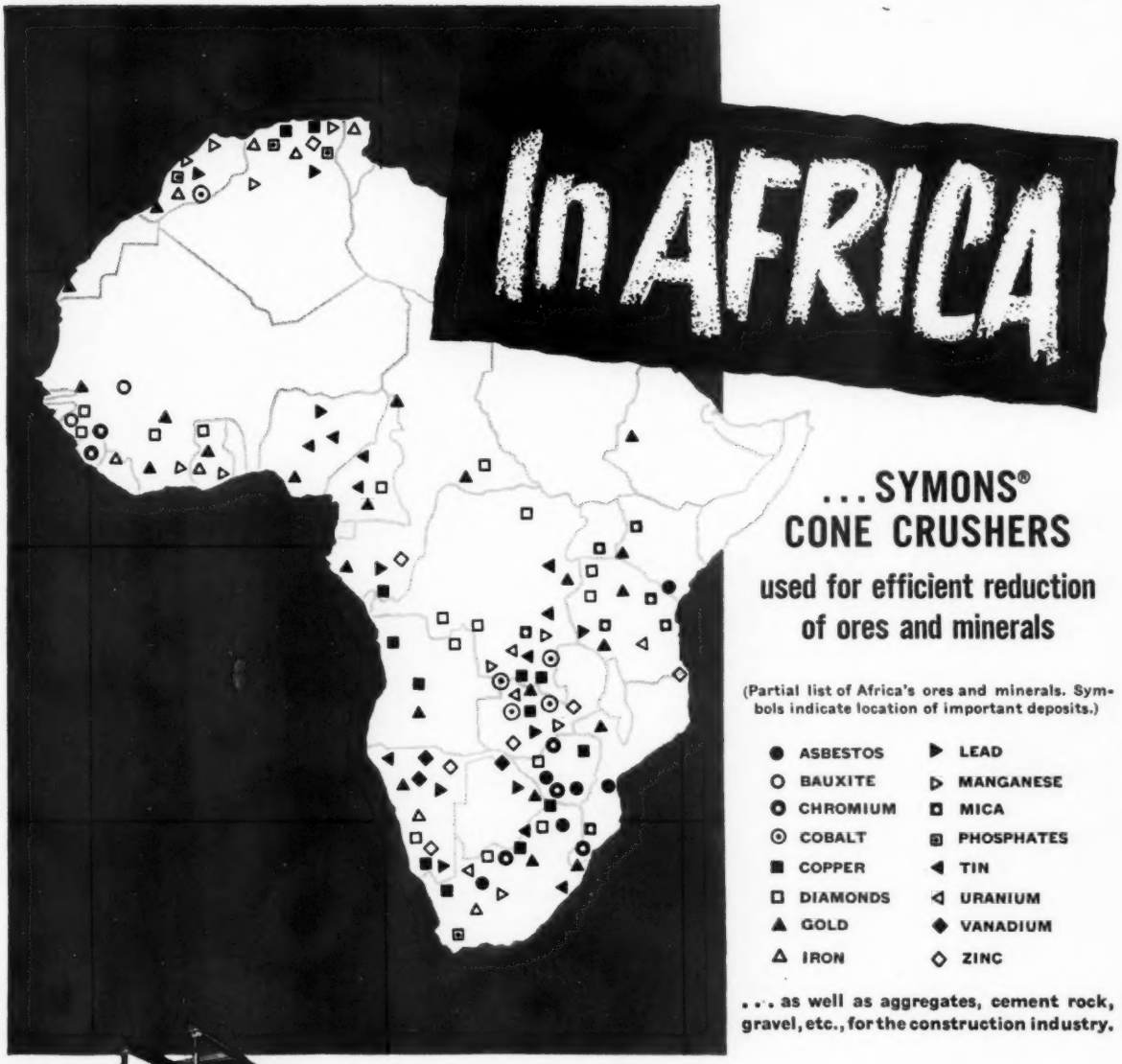


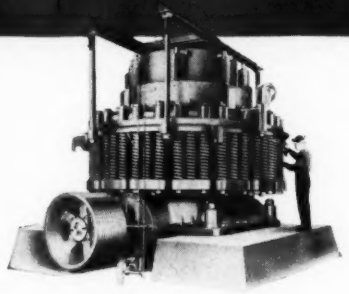
. . . SYMONS® CONE CRUSHERS

used for efficient reduction of ores and minerals

(Partial list of Africa's ores and minerals. Symbols indicate location of important deposits.)

● ASBESTOS	▶ LEAD
○ BAUXITE	▷ MANGANESE
◘ CHROMIUM	◘ MICA
⊙ COBALT	▣ PHOSPHATES
■ COPPER	◀ TIN
□ DIAMONDS	◁ URANIUM
▲ GOLD	◆ VANADIUM
△ IRON	◇ ZINC

. . . as well as aggregates, cement rock, gravel, etc., for the construction industry.



SYMONS CONE CRUSHERS
. . . *The machines that revolutionized crushing practice* . . . are built in a wide range of sizes, for capacities to over 900 tons per hour. Write for descriptive literature.

In all of the great ore and mineral operations around the world . . . there has been no record to equal the performance of Symons Cone Crushers in consistently and efficiently producing great quantities of finely crushed product at low cost.

In Africa, hundreds of Symons Cones are used by leading producers of most of the ores and minerals found in this giant continent. As an indication of its mineral wealth, it is significant to note that Africa produces almost 75% of the world's cobalt, 65% of its gold, 50% of its antimony, 33% of its manganese, chrome and phosphates, 25% of its copper, 15% of its lead and tin, a large part of its uranium and practically all of its diamonds.

The use of Symons Cone Crushers in Africa is another example of the way in which these efficient crushers serve the mining and mineral processing industries of the world.

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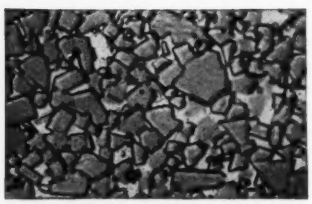
Longer bit life— with *new* Sandvik Coromant Bits



Sandvik Coromant Tungsten Carbide (Microphoto) Uniformity of size, even distribution of grain are marked. Free from porosity and impurities —therefore stronger, longer-lived.

Low quality Tungsten Carbide (Microphoto) Black marks are contaminations caused by deficient production control. They weaken the carbide, reduce its working life.

NEXT time you buy bits, specify Sandvik Coromant because they give more footage per bit, lower drilling costs. Here's why:

1 Only first-quality tungsten carbide is used —as shown in the microphotos above. This means less wear, longer life and a better job.

2 The bodies are precision-made of high quality alloy steel—tough enough to take the strain throughout the extra-long bit life.

3 The bigger Sandvik Coromant bits are all of X-design, which prevents rifling. No wonder Sandvik Coromant inserts are the most widely used in the world, drilling more than one billion feet every year.

SANDVIK COROMANT bits are supplied through Atlas Copco, the world's largest manufacturer of rock drills, who also supply Sandvik Coromant integral steels — the most widely used in the world — and Sandvik Coromant extension steel equipment.

Sandvik Coromant Detachable Bits are Available in the following Thread Sizes and Bit Diameters

Available Diameters, in Inches

Type	Thread	1¼	1⅜	1½	1⅝	1¾	1⅞	2	2⅛	2¼	2⅜	2½	2¾	3	3½	4	4½	5
SHOULDER	TAPER	x	x	x	x													
	F		x	x														
	113		x															
	H			x	x	x	x	x		x								
	115			x	x													
	D						x	x	x	x	x	x	x	x				
	K													x	x	x	x	
BOTTOMING	1" Rope				x	x	x	x		x								
	1¼" Rope						x	x	x	x		x		x				
	400						x	x		x		x						
	1½" Rope											x	x	x	x	x		
	600											x	x	x	x			
	700													x	x			
	J7.5															x	x	
	2" Rope														x	x	x	x
	1000																x	

Write or phone today for further details to either of the addresses below:

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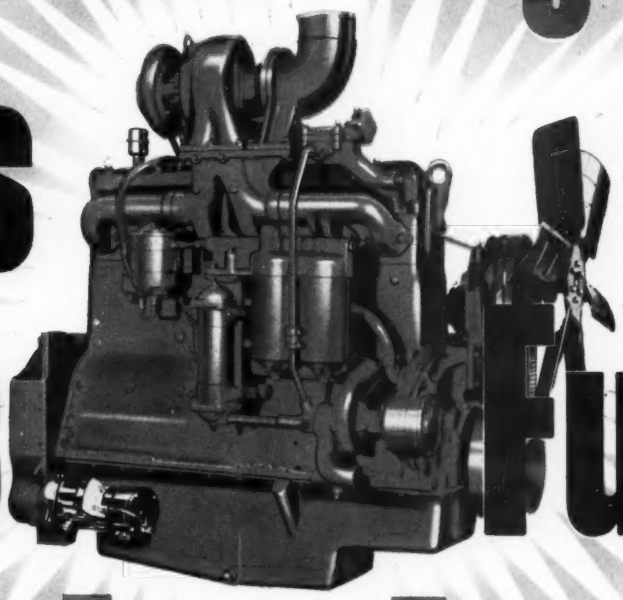
This New Engine Uses Less Fuel Than Any Engine In Its Class



The new Allis-Chalmers 21000 turbocharged diesel engine delivers 340 dynamic horsepower at 2000 rpm — and does it on only ¾ of a cup of fuel, or just .355 lb, — per bhp/hr.

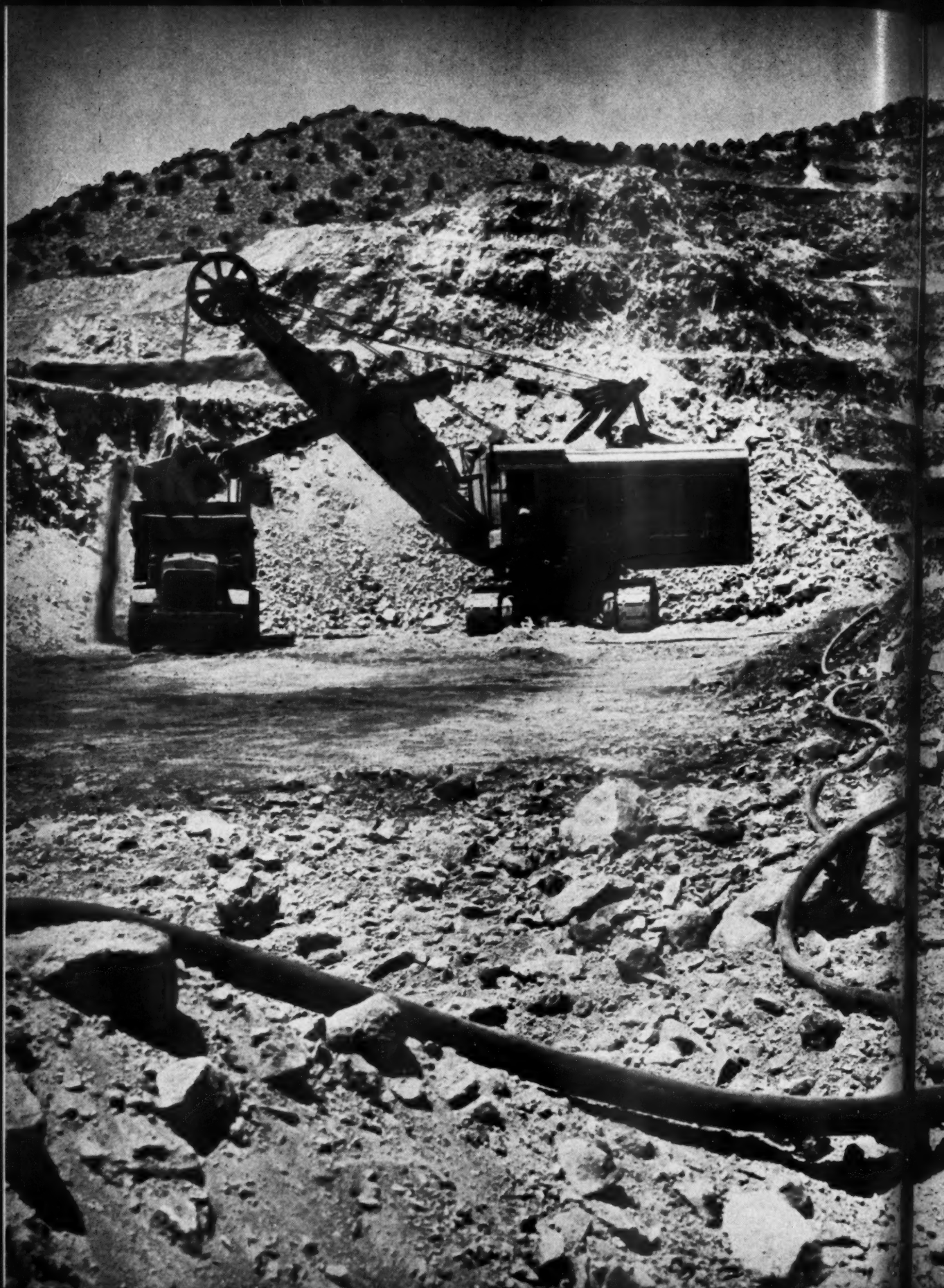
The comparable engine with the next best fuel economy, by published claim, burns between .39 and .40 lb, or almost 10% more.

Another engine in this class burns, according to published claims of the manufacturer, .46 lb per bhp/hr — or 29% more. This means 3 extra gallons to every 10.

The Allis-Chalmers 21000 and companion 16000 (naturally aspirated) engines deliver superior performance because of superior, *advanced* engineering—at least two full years ahead. The famous Allis-Chalmers durability and lugability are still included, too — only more so. Let your nearby Allis-Chalmers dealer show you. Allis-Chalmers, Milwaukee 1, Wisconsin. BE-16

ALLIS-CHALMERS

***POWER* FOR A GROWING WORLD**



YOU GET LONGER LIFE OUT OF ANACONDA SH-D SHOVEL CABLE— WE PROVED IT IN OUR OWN MINES!

Anaconda *uses* shovel cable as well as makes it. The important experience gained from that use and testing of cable under actual field conditions goes into the design and manufacture of the Anaconda Shovel Cable *you* buy.

In Anaconda SH-D Shovel Cable you get cable built to eliminate on-the-job power failures caused by such conditions as sun, jagged rocks, water, kinks, runovers.

The insulation of Anaconda's SH-D Shovel Cable is a special high-grade butyl that withstands ozone, heat and moisture. Patented rubber-cored ground wires help prevent breaks and insulation cutting from kinks and runovers. The neoprene jacket is exceptionally tough and abrasion-resistant. Every design and component has been job-tested—your assurance of superior quality and performance.

Call on the Man from Anaconda with your cable problems. Or see your local Anaconda distributor. For new descriptive Bulletin DM-5818, "Anaconda Securityflex Portable Cables for the Mining Industry," write: Anaconda Wire & Cable Company, 25 Broadway, New York 4, New York. 59213

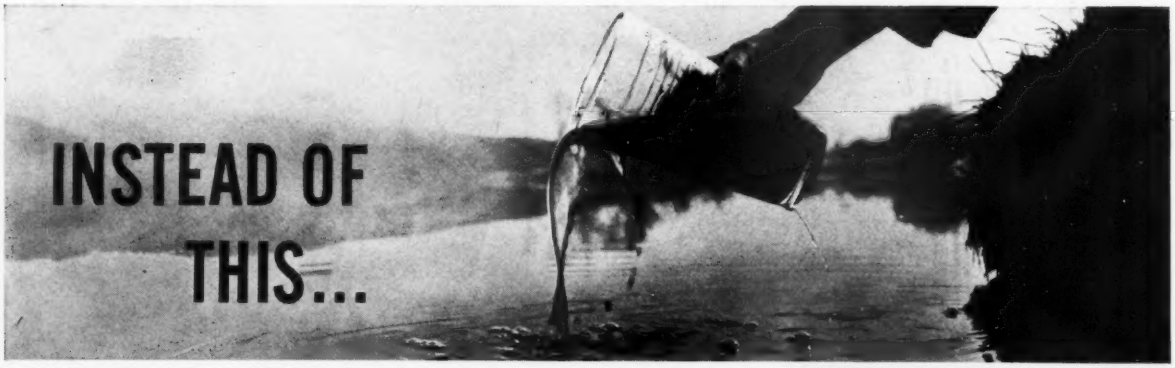
Anaconda SH-D Shovel Cable at work in an open-pit mine. Continual on-the-job testing of Anaconda designs under the roughest conditions enables us to produce extra long-life shovel cables that prevent power failures from heat, moisture, rugged terrain, kinks and runovers . . . all of this saves you money, assures continued and uninterrupted production.

ASK THE MAN FROM

ANACONDA®

FOR SHOVEL CABLE

WEMCO-FAGERGREN FOR FINE COAL FLOTATION



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a division of
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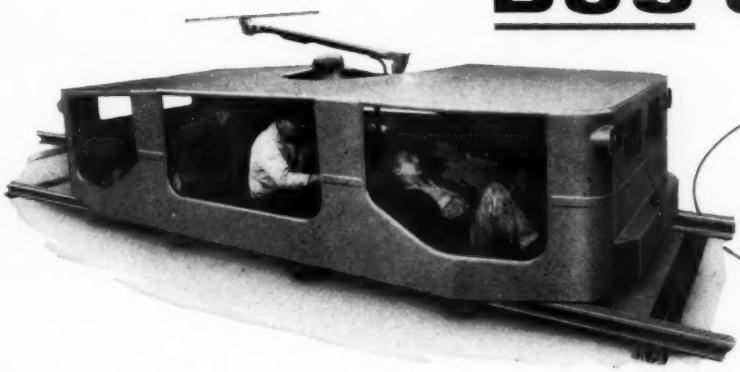
Coal operators now have a solution to washery water reclamation and stream pollution problems, producing, at the same time, a marketable fine coal product! Wemco-Fagergren Flotation Machines are at work in a number of installations, proved in low-cost, efficient recovery of clean coal fines, removal of solids from cleaning plant water and clarification of water for re-use in closed plant systems.

If you have a coal recovery problem, chances are that Fags can turn it to advantage. Ask for complete information now!

coming and going

you take your profits on ~~the~~ every run with the Lee-Norse

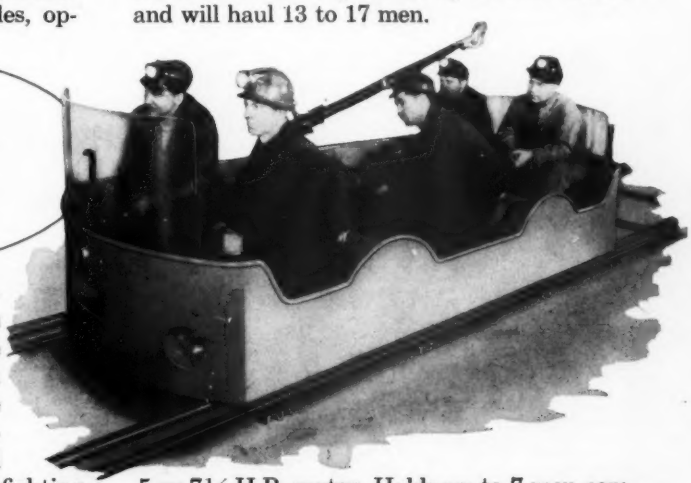
BUS & JITNEY



Lee-Norse
MINE PORTAL BUS

■ There's no wasted motion with this self-propelled Portal Bus because it is fast on the take-off, saving manpower time for conversion into more tonnage. And it is designed for safety, with hydraulic operated running brakes plus mechanical emergency and parking brakes direct on the wheels. For severe grades, optional electric dynamic system produces braking effect from the motor for *extra* safety under all conditions. Also the split roof construction gives operator unimpeded, all directional view, while the trolley pole is always within quick reach. This bus is powered by 15 H.P. motor and will haul 13 to 17 men.

Lee-Norse
MINE JITNEY



■ The Mine Jitney is the "Jack-of-all-Trades" of the mine fleet because its versatility enables it to be used on the regular job and for emergency. It can handle the job of furnishing fast, safe transportation of key personnel, maintenance crews and special groups; and can double up as an ambulance or fire-fighting equipment car. Designed with twin braking systems for added safety. Powered with either 5 or 7½ H.P. motor. Holds up to 7 men comfortably. Optional equipment: Plexiglas windshield, fire extinguisher, stretcher equipment.

Lee-Norse Company
CHARLEROI, PENNSYLVANIA

SPECIALISTS IN COAL MINING EQUIPMENT

He wastes no time!

He pinpoints faults with an O-B Locator!

When a fault hits his trailing cable, he wastes no time. He pulls the plug and goes for his O-B Cable Fault Locator.

It takes him only a minute to clip two leads to the power conductors, two to the small six-volt battery—and he's ready for testing. Testing is simple too—a slow walk back along the cable with earphones and slim transistor receiver. When he hears a change in signal he's found the short or open and can make repairs.

If you've been wasting too much time tracking down hidden faults, you could use an O-B Locator, too. It's pocket size, weighs only four pounds, costs less than any cable you'll use it on. Send for Booklet K-423 for complete information.

Ohio-Brass

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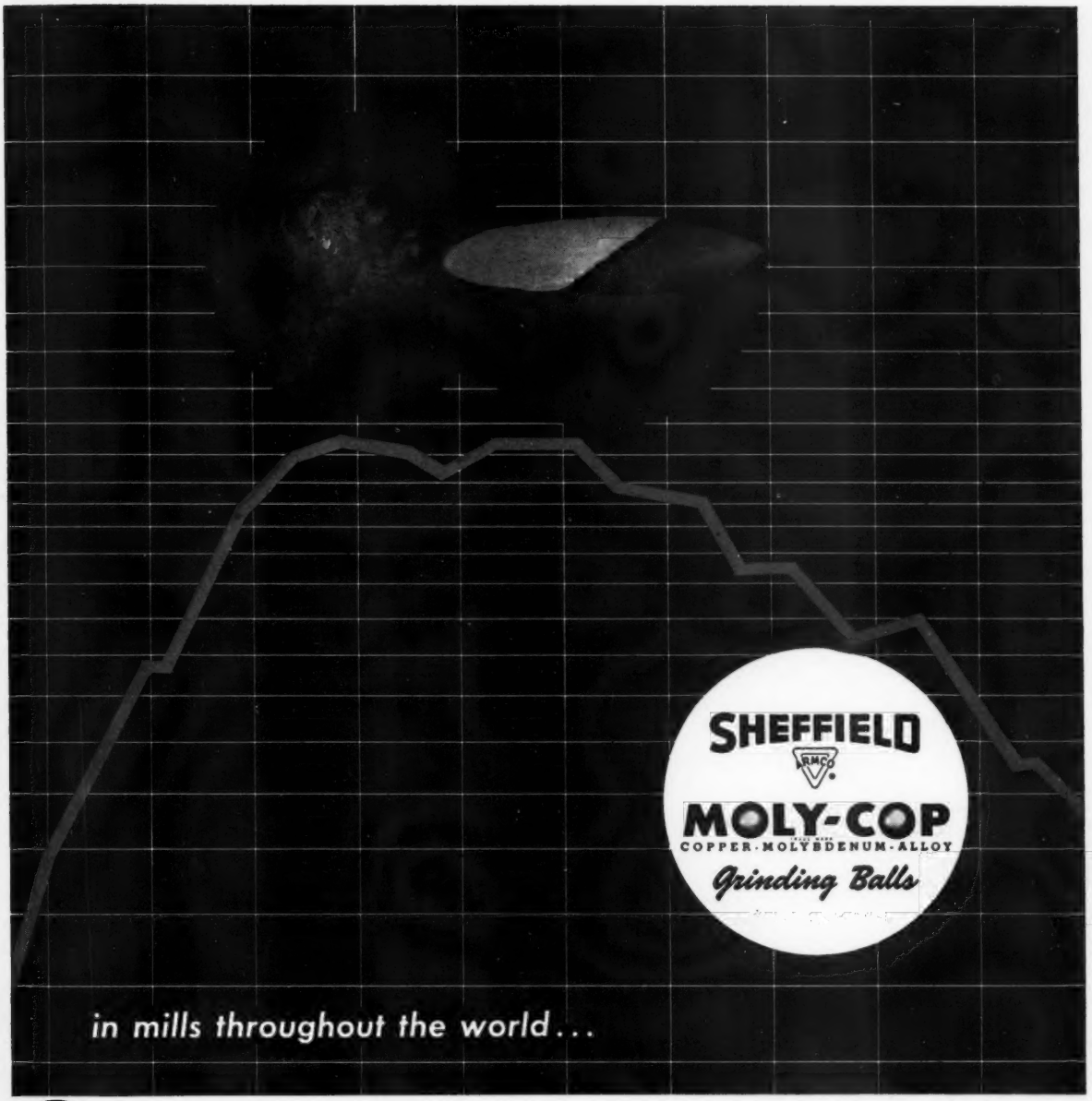

The Standard of Comparison for PEAK PERFORMANCE

In every product field there's an acknowledged leader—the standard of comparison against which all others are measured. In grinding balls, that standard of quality is Sheffield Moly-Cop. The reason: in performance tests by mill after mill, Moly-Cops give longer service, less down-time, and other production economies.

New steels are born at Armco

SHEFFIELD DIVISION

ARMCO STEEL CORPORATION

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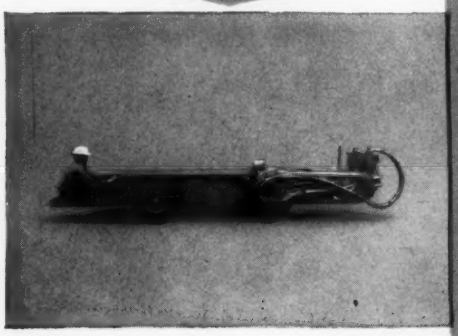
FOR STATIONARY AIR COMPRESSOR USERS...

THE ACME JUMBOLTER

Model HSJ



FASTER AND EASIER!

Time studies have proven that under most mine conditions the ACME JUMBOLTER installs roof bolts 3 times faster than hand held machines.

LET THE MACHINE DO IT!

The ACME JUMBOLTER takes the heavy lifting and hauling out of roof bolting. Finger tip control positions the stoper at any desired point. Two stopers will cover any point in a space 23' 10" wide without moving the JUMBOLTER. Arms reach 9' in front of the machine and swing 270°. No blocking is required for uneven top. Ample space provided to carry the day's supplies.

The ACME JUMBOLTER was designed to furnish a quick and easy method of drilling Roof Bolt holes where a mine is equipped with stationary or semi-stationary air compressors and having air piped to the working face.

The unit is self propelled with full hydraulic drive and hydraulic steering. It is equipped with two Stoper Jumbo Arms and is complete with Stopers and Dust Collectors. Cleveland Model S12V Straight or Telescoping Leg Stopers or Model S20 Stopers may be used. All equipment is Bureau of Mines Approved. Best operating Conditions in seams 42" to 108" high.

We will demonstrate in YOUR mine. For more detailed information write or call —

ACME MACHINERY COMPANY

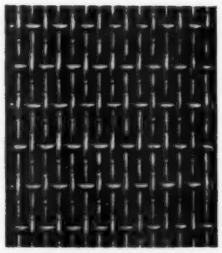
ACME MACHINERY COMPANY

HUNTINGTON, WEST VIRGINIA

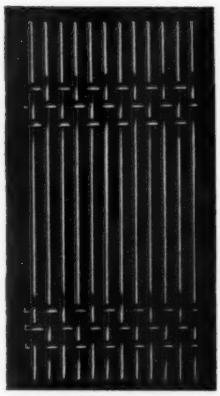
WAREHOUSE AND SALES OFFICE
MORGANTOWN, W. VA.

REPRESENTATIVES IN PRINCIPAL MINING AREAS

When you order screens, be sure to specify the type which best meets your requirements. For example:



For maximum through capacity, CF&I Space Screens with rectangular openings are recommended. The high percentage of open area provides considerable freedom from blinding or clogging.



For maximum freedom from blinding or clogging, CF&I Long Slot Space Screens are the most efficient construction. Because of the open area and intense vibration of wires on the long sides of the openings, material can not cling or build up.

* * *

Whatever your screening operation, our engineers will be glad to help you select the optimum screen for your needs.

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SPACE SCREENS

for less downtime . . . long screen life . . . accurate screening

Symbol for the dependability of all CF&I steel products, the giant steelman can be relied on for tough, precision space screens.

CF&I Space Screens are ideal for rugged screening operations because they are made from quality steel, and are available in a wide selection of types, weaves, crimps and edge preparations. They give long service and, consequently, fewer work stoppages and greater tonnage output for your screen dollars. CF&I Space Screens are tightly woven to retain uniform spacing and openings, thus assuring accuracy under the most demanding screening conditions.

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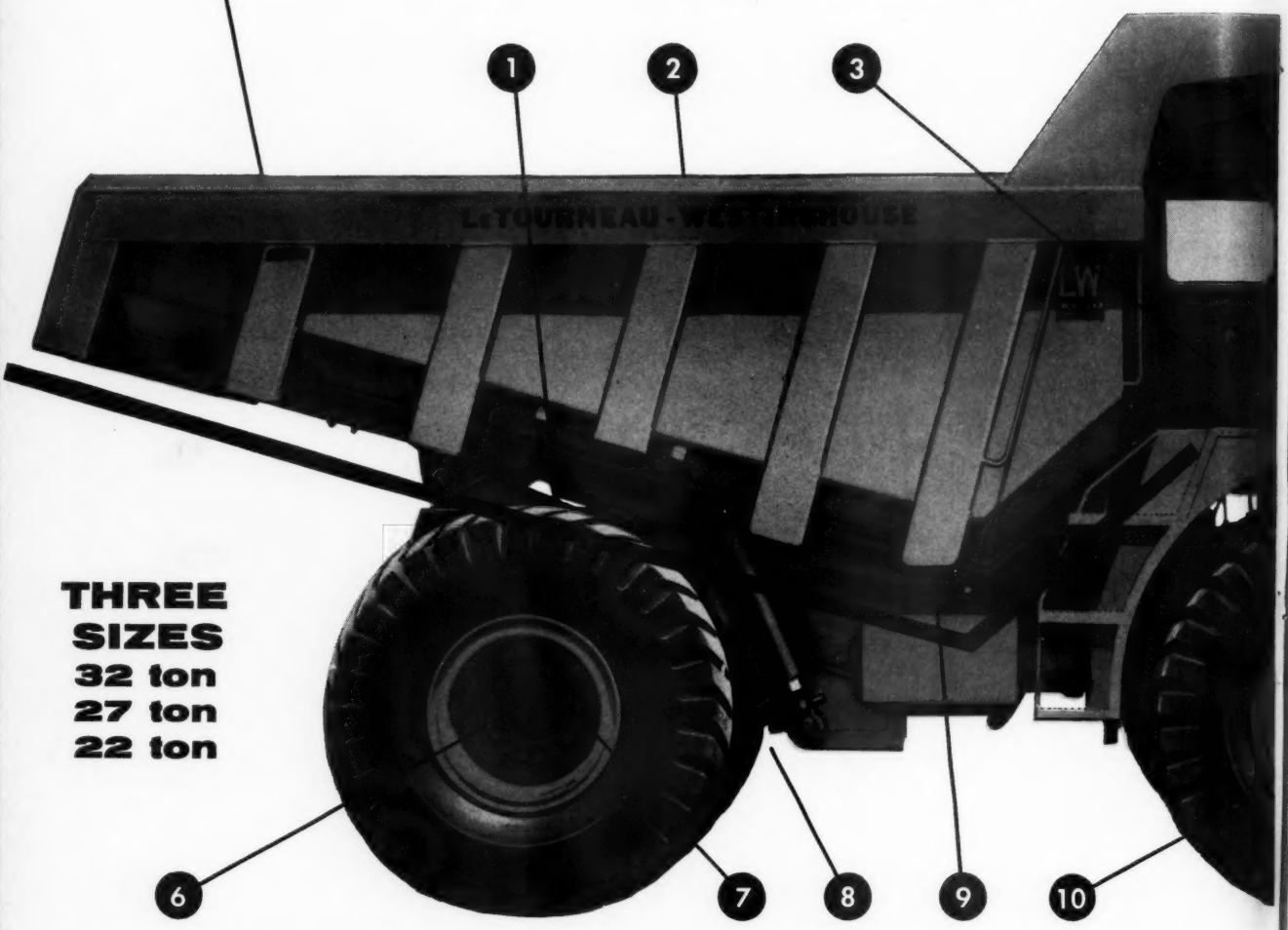

THREE SIZES
32 ton
27 ton
22 ton

Look at these important advanced Haulpak features!

1. "V"-shaped body — gives you bonus yardage within a short wheelbase. Loaded material quickly fills all corners for big low-void pay loads. "V" also provides a low center of gravity . . . gives Haulpak the stability needed for high-speed hauling over rough roads and steep grades.

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3. Big, roomy cab — with canted windshield has many work-efficiency features.

4. Strong, protective canopy — covers cab completely.

5. Positive power steer — and sure-grip, auto-size steering wheel — for safe, easy handling. Steering system is located high behind bumper, well protected from damage.

6. Exclusive power-transfer differential — automatically transfers power to wheel on firmest footing for maximum traction. This same, patented LW differential has boosted production and profits for thousands of LW Tournapull® owners for more than 14 years . . . and now, *for the first time,* it is available on a truck.

7. Needs *NO* daily maintenance — Haulpak's bearings never need lubrication . . . they're moly-coated to resist abrasion, packed in grease, and sealed for life. The entire Haulpak lubrication check — *needed only at 500-hour intervals* — consists of just 4 easily-reached grease fittings.

8. Has no springs, rides on Hydrair* — Haulpak's exclusive air-hydraulic suspension system completely eliminates maintenance and repair of springs. 4 Hydrair units cushion against loading and travel shocks. System compensates *automatically* for off-center loading and keeps unit riding level over humps and holes.

9. 100% rubber-mounted body — cushions loading shocks. Engine, transmission, radiator, and cab are also rubber-mounted to minimize vibration.

10. Four separate braking systems — two controlled by hand levers, two by floor pedal — for fast, safe, sure stops. System includes Torqmatic brake in the Haulpak transmission and big, disc-type air brakes on all wheels having 4 times the braking surface of conventional trucks.

11. "Power-Miser" fan — standard on all Haulpaks, requires only 10 hp to operate, compared with the 30 to 35 hp needed for conventional fans. Thermostatically controlled, fan shuts off *automatically* when engine heat falls below efficient operating temperature . . . permits engine to maintain correct temperature, releases more horsepower for tractive effort.

180° turn in area only 44½' wide — with a wheelbase of only 130", Haulpak turns in far less space than units of similar capacity. This unusual maneuverability permits Haulpak to spot, swing around, back up, and dump without lost motion to delay hauling cycles.

Haulpak®

Hauls more tons per man-hour!

This LW Haulpak is all new from the wheels up. It is the result of more than 3 years of research and development by LeTourneau-Westinghouse engineers — pioneers of a long list of earthmoving and hauling equipment. Although brand new, Haulpak is a fully-proven truck. All three models have been put through rugged tests under the toughest working conditions for over 14 months — in mines, quarries, and on construction jobs. Its various parts and assemblies — some of them tested and proved by *millions of hours* on LW Tournapulls all over the world — are much stronger than those on ordinary haulers. With the all-new LW Haulpak truck you can be confident your truck maintenance, repair, and operating costs will drop to a new low . . . and your hauling tonnage will climb to new highs!

Check the job-tested Haulpak features listed here. Then visit your nearby LeTourneau-Westinghouse Distributor . . . let him give you detailed specifications on the new Haulpaks. Call on him soon!

*Trademark HP-2099-G-2

LW Parade of Progress continues:

The new Haulpak truck is the latest addition to an impressive line of new and improved earthmoving and hauling machines being unveiled by LeTourneau-Westinghouse Company. They're part of LW's continuing program of product development to give you highest production equipment at lowest ownership-operating cost.

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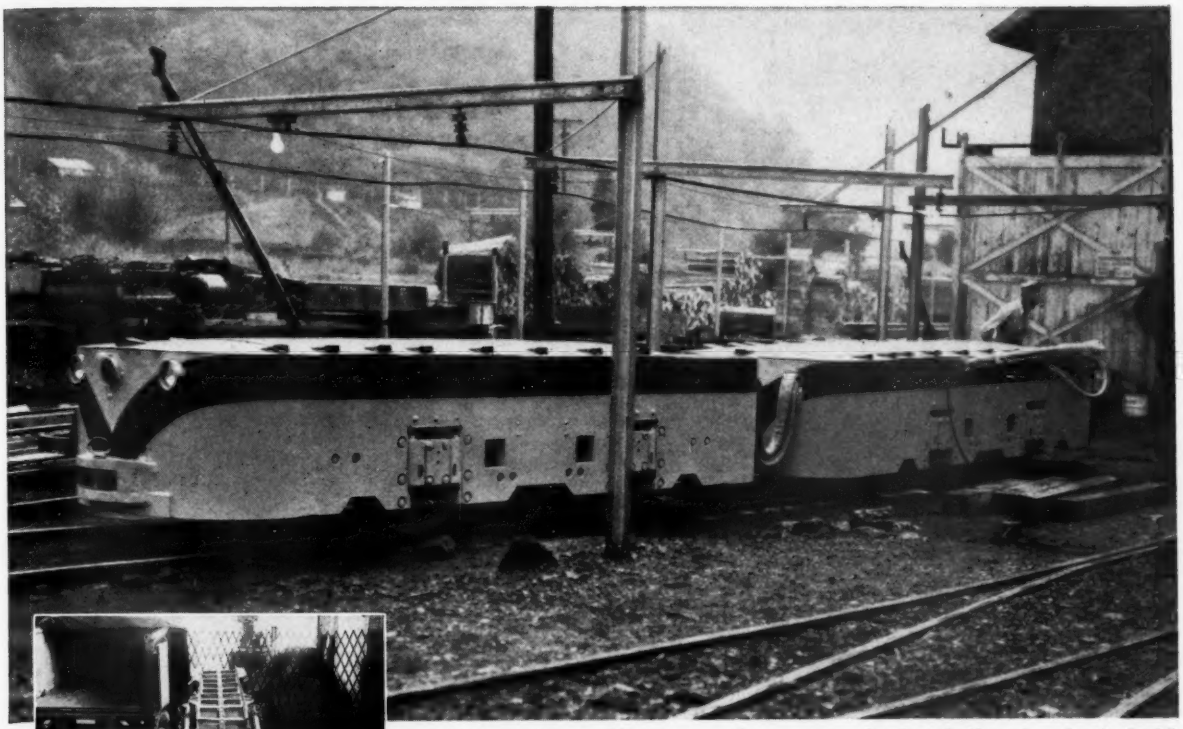
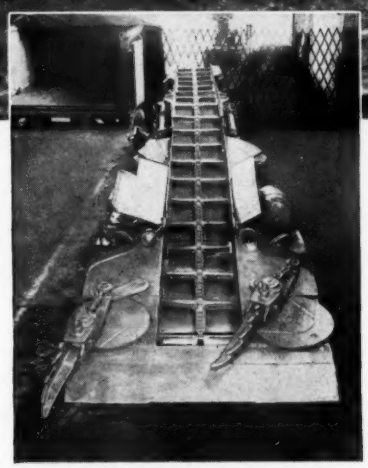


Back on the job. *Mine locomotive was completely rebuilt and modernized with contactor control, air brakes, air sanding and new bumpers.*



Not brand new but National new. *Rebuilt coal loader is one of many types of machines serviced by National's two coal field plants; in Bluefield, West Virginia, and Harlan, Kentucky.*

Get complete equipment rebuilding from National

The Specialists in electric coils/repair service

National offers not only electrical repairs but complete rebuilding service on all types of mining machines.

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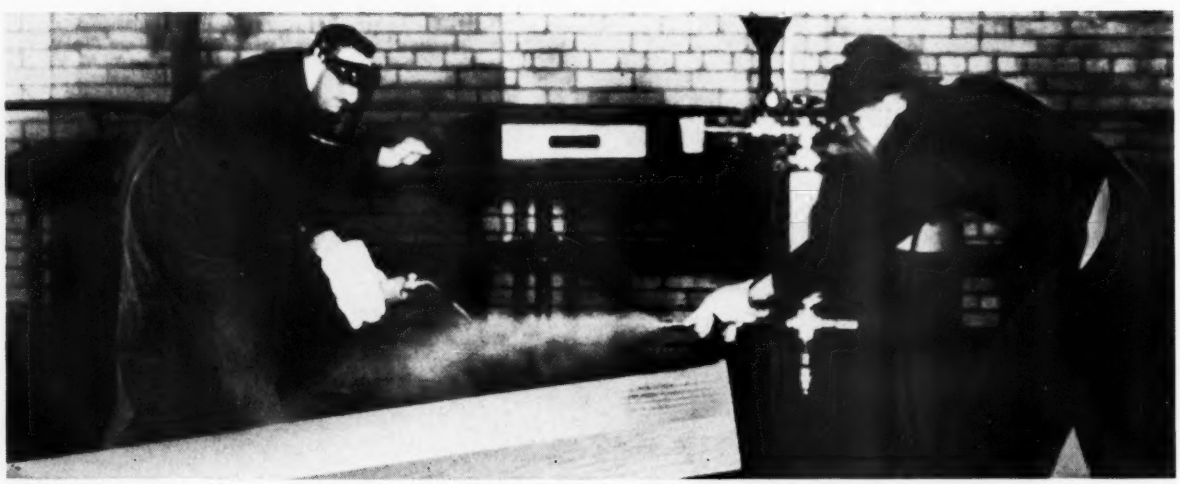
First low-cost

Flame tests prove fire-resistant properties of this hydraulic oil

Dramatic photo above shows flammability of conventional hydraulic oil.



Not so dramatic, but . . . see how Shell 3XF Mine Fluid resists flame.

Photos courtesy: U. S. Bureau of Mines

SHELL 3XF

fire-resistant mine fluid

Shell 3XF Mine Fluid has been tested by U. S. Bureau of Mines and is now in use

Now—for the first time in mining history—an inexpensive, fire-resistant emulsion-type hydraulic fluid is available for mine equipment use—Shell 3XF Mine Fluid.

NO MAJOR MODIFICATION OF EQUIPMENT IS NECESSARY—Shell 3XF* is a direct replacement for ordinary hydraulic oils now in service.

CONVENIENT TO USE—Shell 3XF Mine Fluid, furnished as a concentrate, is mixed with water to prepare the emulsion *at the mine location.*

PROOF OF ITS FIRE-RESISTANT QUALITIES—In addition to recommending the use of fire-resistant hydraulic fluids in mining machinery, the Bureau of Mines has evaluated Shell 3XF Mine Fluid using test methods that determine fire-resistant properties, and accepted it for Mine evaluation, pending the establishment of a Bureau approval schedule.

FOR COMPLETE INFORMATION on Shell 3XF Mine Fluid, write or call Shell Oil Company, 50 West 50th Street, New York 20, New York, or 100 Bush Street, San Francisco 6, California. In Canada: Shell Oil Company of Canada, Limited, 505 University Avenue, Toronto 2, Ontario.

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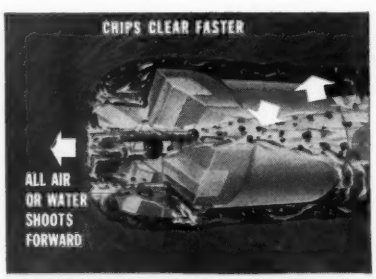
IT'S removable—yet the new Timken® tapered socket carbide insert bit for air-leg drills is one-piece strong. With this tapered union you get all the advantages of removability, and the strength of one-piece steel.

Removability of the new Timken tapered socket bit gives you all these advantages you can't get with intraset steels:

1) No need to throw away good drill steel when the carbides wear out. With intrasets you have to throw away good steels. 2) A pocketful of bits is enough for a day's work. You haul an armful of steel with intrasets. 3) You can change bit gauge sizes fast on the same steel. Using intrasets, you have to change the whole steel. 4) You carry only the bit to the shop for resharpening. With intrasets you lug the whole steel. 5) You get longer gauge wear because there are four carbide cutting edges. Most intrasets have only two.

The new Timken tapered bit's new frontal design features clear chips faster (right). And you get superior wear-resistance with added shock-resistance because of new special-analysis carbide inserts. They can be reconditioned many times.

To get removability *plus* strength, get the new Timken tapered bit. For free brochure, write The Timken Roller Bearing Company, Rock Bit Division, Canton 6, Ohio. Cable address: "TIMROSCO".



CHIPS CLEAR FASTER because 1) five front holes shoot water or air directly against the rock face and 2) deeper, wider wing clearance lets chips wash back faster.

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THE AIR-LEG BIT OF THE FUTURE

EDITORIALS

ROBERT W. VAN EVERA, Editor

JULY 1959

On Industry Cooperation

The good spirit of cooperation between those engaged in the mining industry has been lauded many times on this page. It is in the area of safety that these efforts have reached a peak, with first aid and mine rescue teams serving as excellent examples.

Recently a dramatic rescue of three miners trapped by a large roof fall in a western Kentucky coal mine captured the attention of the Nation. The men were caught at a room face of a highwall mine some 450 feet from the portal. Rescue attempts were hindered by the size of the fall and the suspicious nature of the overburden, which made the success of any attempt to reach the men by sinking a large borehole open to question. Fortunately, a neighboring coal company had a continuous mining machine, which had just undergone an overhaul, on the surface, and a telephone call was all that was needed to put the wheels in motion to have the machine trucked the sixty miles to the stricken mine.

Once on the job, the continuous mining machine was put to work driving an entry through solid coal next to the caved entry, and in twenty-five hours had reached and freed the trapped men.

This is the type of cooperation of which our industry is justly proud.

A Helping Hand

The mining industry of the State of Idaho recently delivered a $250,000 check to the University of Idaho's board of regents. The money will be matched by an equal amount from the State legislature, and a new building for the College of Mines will be erected. We regard this as a heartening example of how industry can help education.

On visiting the university in 1956, mining industry leaders saw that existing facilities at the college were inadequate and outmoded. But the university's President, D. R. Theophilus, pointed out that enrollment in mining and metallurgy was too small to justify asking the taxpayers to pay the full cost of a new building. Industry, university and State officials, not content with this unsatisfactory situation, got together and set up a joint participation plan where the State legislature appropriated $250,000 for a new building on the condition that the mining industry contribute an equal amount.

L. J. Randall, president of Hecla Mining Co., headed the industry's finance committee which solicited companies, alumni and individuals interested in the college. The result was a complete success. Although Idaho's mines were feeling the pinch of a tight economic climate, the goal was reached ahead of schedule.

There is no doubt that the Idaho mining industry will benefit from its generosity to the university, and certainly the entire mining industry, without State boundary limitations, will gain by this good work. It is clear that the industry recognizes its responsibility to mining education by its increased expenditures for student aid, classroom equipment and by the willing employment of students during vacations.

For this it deserves a "pat on the back."

All That Glitters Is Not Gold

For quite some time the coal industry has been wanting to try diesel haulage underground. The present rapid transition to a-c power for face equipment has increased this desire in many quarters because it would dispense with the need for a dual electrification system in mines which use rail haulage.

We feel sure that the time is coming when the industry will not be restricted, as it is now, from using diesel equipment; all of which leads to a word of caution. Coal miners for the most part are born optimists and there is the danger of considering diesel haulage as a panacea for underground transportation.

A short time ago two representatives of the Australian coal industry dropped in for a brief visit. In discussing this point, they said that they had diesel haulage in many of their mines and would like to switch back to electric haulage. The reason for this attitude was the comparative cost of maintenance. Although, as they put it, the maintenance cost of electric locomotives was reckened in pence, maintenance of diesel equipment was counted in shillings.

This is not to say that our coal industry should be arbitrarily restrained from proving the economics of diesel haulage—we are convinced that its use will not introduce a health hazard—but instead to point out that, as in any new technique, all factors should be carefully studied.

MECHANICAL MINING

in Eastern Tennessee

American Zinc's experience covers a variety of equipment working in three mines under a wide range of operating conditions. The switch to mechanical mining has played a big part in reducing costs. The author cautions, however, that heavy machinery is not a cure-all, and the final answer to lower costs cannot be found in any single piece of equipment

By

HARRY L. MILLER

Superintendent
Jefferson County Operations
American Zinc Company of Tennessee

The original equipment at North Friends Station mine consisted of three Koehring Dumptors (above), two Eimco 104 loaders and three Joy Drillmobiles. All of this equipment is still in service to some extent — the three Dumptors having hauled a total of about 800,000 tons

AT the present time there are three companies mining zinc from six mines in Eastern Tennessee. Two additional mines are inoperative due to market conditions. All but two of the eight mines have some form of diesel equipment underground. The types of diesel equipment and other pieces of mechanical equipment vary over a wide range. This is to be expected because of the physical differences in the ore bodies.

The ore bodies are all in the same stratagraphic horizons, but there is considerable difference in the dip and amount of faulting between

mines and within any given mine. The ore bodies are irregular in all three dimensions which often seriously complicates the application of mechanical equipment. There are only a few ore bodies within the district that have the flat or low-dipping floor which is such a desirable condition for trackless machinery. The stope backs are usually even more erratic.

The country rocks are dolomite and limestone of the Kingsport formation which usually stand well over reasonable spans in the room and pillar system of stoping.

The following is a brief account of American Zinc's experience in the mechanical equipment field for the past eight years at their Tennessee mining operation.

Experience With Diesel Equipment Started in 1951

American Zinc's experience with diesel equipment started in 1951 with driving an 1100-ft incline to develop the 500-tpd North Friends Station mine. Since then, use of diesel equipment and other mechanical equipment to cut costs has grown steadily. The company now has 16 diesel loaders along with numerous other pieces of mechanical equipment underground. The diesels load about 2800 tpd.

The original equipment at North Friends Station mine consisted of three Koehring Dumptors, two Eimco 104 loaders and three Joy Drillmobiles. All of this equipment is still in service to some extent. Another type diesel, crawler-mounted, overshot loader was used for a while but with limited success. A large part of the production has been loaded with a Gismo. In April of 1958 a Hough Payloader, Model H H, was put into service. The company was particularly interested in gaining some experience in the use of rubber-tired equipment in its operations.

North Friends is now in the "clean-up" stage and has produced about 800,000 tons. All of this production has been hauled with the three Dumptors.

From experience gained with equipment at North Friends Station and American Zinc's Grandview mine at Metaline Falls, Wash., it was decided to develop the Young mine for use of Gismo equipment. Depth of ore bodies and other physical conditions resulted in a vertical shaft rather than an incline entry.

Briefly, the Young mine was developed by four levels connected to the six compartment shaft. Recently a connection has been made to a 5½-ft diam shot drill ventilation shaft. Vertical displacement on an east-west fault separated the ore horizon by 140 ft. This made it necessary to have four levels, two levels for ore north of the fault and two levels for the south. In each case one level is a track haulage level located below the ore horizon with chutes and raises connecting to the upper level, which is located within the ore.

The track haulage levels are 12 by 12 ft with 60-lb rails on 48-in. gauge. The haulage equipment consists of eight-ton Sanford Day bottom dump cars pulled by 13 ton trolley locomotives. The haulage levels are driven on ½ percent gradient with Gismo loaders and Gismo jumbos. The broken muck on levels is loaded into the cars by use of the "ramp and piggyback" system.

The trackless levels are also driven with Gismo equipment. These levels are kept within the ore horizon and are not held to any particular gradient.

Ore in the stopes is broken by use of Gismo jumbos, Drillmobiles and airlegs, depending on conditions in a given area at a given time. The broken ore is loaded and hauled to transfer raises, which are located about 600 ft apart, with the Gismo loader.

The Young mine has been in production for almost three years and has produced about 800,000 tons of ore. With only minor exceptions, this tonnage has been loaded with Gismos.

American Zinc is in the process of developing the Coy mine with the use of Gismos. Unlike the Young mine, each ore body will have connections to only one level. The steeper dipping, smaller, more scattered ore bodies which are located in more than one stratagraphic horizon do not justify the two level system. Much of the ore is located well above the levels which makes it essentially inaccessible to large equipment such as Gismos. Such ore bodies will be mined with the conventional slusher and airleg. Gismos and Drillmobiles will be used where ore is cut by levels. The track haulage and hoisting equipment is the same as is used at the Young.

Maintenance is of prime importance to the success of a mechanization program, but one man working on roadways can often eliminate the need for two mechanics in the shop. Equipment specifically designed for roadwork is a good investment

Maintenance Second Only to Safety

Experience with mechanical equipment has taught American Zinc several important points on application, operation and maintenance. Some points have been learned the hard way.

Mechanical equipment and its application in mining is by no means fixed or static. The company is constantly learning, not only from its own experience but from other companies as well. Exchange of ideas and information within the district has

been and will continue to be a big help.

No machine can be operated without some repair work; and the performance of any machine will not be any better than the condition in which it is maintained. Repairs often add up to the largest single item of cost. There are many variables which have a direct bearing on repair costs. Often methods of operation must be altered to prevent excessive maintenance. Generally speaking, maintenance problems are considered secondary only to safety. Company maintenance is based on the old saying, "A stitch in time saves nine."

In order to have effective repair work, one must have skilled mechanics, ample shop facilities, a supply of spare parts and complete cooperation between repair crews and operators. None of these things come easy but must be created by the supervisors with full support of top management.

American Zinc has made big cuts in its original repair costs at Young mine by increasing the application of these known principles and by using numerous techniques originating within its organization. The manufacturers have made improvements and changes in design that are cutting both operating and repair costs. There is still plenty of room for improvement which must come in order to enable the company to remain competitive with other suppliers of zinc.

The author would like to cite two examples of simple things that have made big savings on repair and replacement costs. At one time, the bolts that fastened the shoes to the track rails on the crawler tractors could hardly be kept tight. Time and money were expended tightening bolts, replacing bolts and shoes. By use of the proper welding rod, the shoes are now welded to the rails and this problem has been eliminated. By welding only three hard surface beads on the flat shoes, traction has been increased without causing the harmful vibration often encountered with use of semi-grouser shoes. Of much more importance, this small amount of hard surfacing has greatly increased the shoe life. Many shoes, previously considered worn out, were reclaimed.

It is very important to give the tractors a complete inspection about every 25 hr of engine operation and perform all indicated repairs before returning them to the operating section. Regular preventive maintenance is performed even more often, along with minor inspection and repairs, if required. These practices are essention to low maintenance costs and minimum down-time.

Equipment Limited to Certain Range of Application

The selection of any equipment for mining is largely governed by physical aspects of the ore body to be mined. The same principle applies to selection of mechanical mining equipment. There are no universal machines; each piece of equipment has its range of application, and some are limited to a rather narrow range. Flexibility is a most desirable feature to have in all machines, but at times one must sacrifice some flexibility in favor of speed or some other point. Where many physical conditions cannot be accurately measured on a new ore body, range of application and flexibility can be more important than speed.

It is relatively easy to change machines to fit an ore body and the proper mining scheme, but impossible to change the ore body and often difficult to change mining method to conform to the machine. More often than not, some practices must be changed to get best results with a new piece of equipment. American Zinc is constantly changing practices to get better results. All changes have not produced desired results and have required further altering of plans. A proper attitude on the part of the crews concerning such matters is a contributing factor to success.

No machine performs better than the operator, which brings up the point of training. This again is not an easy or automatic item. Training operators always complicates a production schedule. It is much easier to train a man initially in proper technique than to break him later of unsafe, costly and sloppy habits. Wherever possible a skilled supervisor, with no other responsibilities, should be used for training new men. The regular production supervisors must also be educated on proper methods and techniques in order that results of training are carried forward into regular operation.

Of particular importance, in both maintenance and operation of trackless loading and hauling equipment, is the condition of roadways. Too much emphasis cannot be placed on this point. Equipment designed for

1. ***Good maintenance is second only to safety as a requisite for a successful mechanization program.***
2. ***The type of mechanical equipment selected depends largely on the physical characteristics of the ore body to be mined.***
3. ***Mining practices and development layout should be based on the limitation of machines selected.***
4. ***Training of operators and mechanics is of great importance.***
5. ***Well maintained roadways for trackless equipment pay dividends.***
6. ***Four machine jumbos are well suited for rapid heading advance.***
7. ***Use of two machine jumbos results in lowest breaking cost where they can be utilized.***
8. ***Airlegs can be used economically where jumbos are not suited.***
9. ***Gismo loaders are applicable and do a good job in thicknesses down to eight ft and on hauls up to 700 ft long. A new unit, with both tractor and Gismo mounted on rubber, shows promise of increasing range and lowering costs.***
10. ***Overshot loaders are fast in heading work where higher head room is justified.***
11. ***Rubber tired machines offer maintenance savings over crawler type equipment.***
12. ***Rail haulage is often cheaper than trucks, depending upon such factors as tonnage and haulage distances.***

this work, such as bulldozers and roadgraders, are a good investment. Excessive water complicates roadway maintenance. Ample ditching must be provided just the same as with rail haulage. One man working on roadways can often eliminate the need for two mechanics in the shop.

Use of Various Equipment Described

Opinions on application and ranges of each piece of equipment cannot be stated in specific terms but only in a general manner. It is doubtful if there is a more controversial topic in the whole subject of mechanical mining equipment.

For example, consider the application of the company's drilling equipment. Three distinctly different drilling machines are used: the four-drill Gismo jumbo, the two-drill Joy Drillmobiles, and regular airlegs. Each one uses a different size of rock drill, an undesirable situation from the maintenance standpoint, but necessary for efficient operation.

The four-machine Gismo jumbo is used where maximum speed of advance is the controlling factor, or for ore-breaking from a very large face. These jumbos lack the desired feature of being self-propelled. Due to their size they cannot be efficiently utilized in confined headings for work other than drifting. The principal use of the Gismo jumbo is for development work and rapid opening up of new ore blocks.

The two-machine, rubber-tired Drillmobile propelled by pneumatic drive motors, is the preferred drilling machine within its range. Lowest breaking costs are obtained from the Drillmobile where it can be used effectively. The company is in the process of building a two-machine jumbo using an old diesel truck as a mounting. This unit probably will be even more mobile and useful than the Drillmobile.

Where conditions will not permit use of a jumbo, the reliable and versatile airleg comes in. The airleg is necessary in steep dips, stopes entered through long raises and where ore is even more erratic than usual. It is perhaps best for over-all grade control in selective mining.

For stope loading and drifting, the Gismo loader is doing a very good job within its range of application. Its range is limited to mucking on grades approaching 18 percent which is probably the limit for other diesel loaders. The transport limit, depending on practical alternatives, is about 500 to 700 ft. Minimum headroom for loading is eight ft.

The company has had trouble bringing repair costs on Gismo loading units down to predicted levels, but during the past year this goal has been achieved. Now a program is in progress that will make additional reductions in both operating and repair costs.

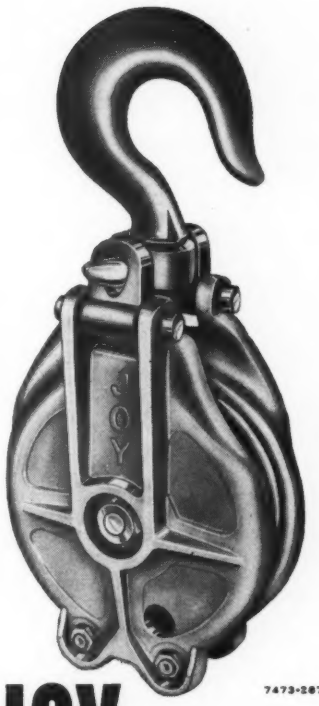
The running gear of both the Gismo and tractor has been the source of largest repair bills. It has been demonstrated that changing the running gear of the Gismo from crawlers to rubber tires is better both for operating and maintenance. Now Sanford-Day is going ahead with a rubber tired tractor. This unit is expected to haul much farther due to increased speed. Practical limits on transport range will be determined during testing. The increased transport range will in many cases make substantial savings in initial development work.

To date, American Zinc has had only limited experience with the Hough Payloader. It is being used to load Koehring Dumptors and is doing a good job in this application. It is not as fast as the overshot loader, or as maneuverable in confined quarters as crawler-type loaders, but appears to offer an attractive saving in maintenance. This machine is competitive with the Gismo loader for short transporting distances and has an advantage in being able to dump into cars or trucks without need of auxiliary equipment. Strict attention is required in operating this rubber-tired unit to prevent excessive tire cost.

Overshot diesel loaders are preferred for trackless drifting where required headroom is justified.

As for haulage, that is, tracks as compared to rail haulage, so many variables must be considered that a brief comparison is not possible. Generally speaking, rail haulage is the cheaper, providing distances and tonnage involved are great enough to justify original development and installation. The Young mine haulage costs are roughly one-fourth of the same costs at the company's other mines using track haulage. This reduction is the direct result of larger rolling stock on wider gauge track, along with an improved chute and good fragmentation.

American Zinc hopes to get more reductions in its over-all mining costs through improvements mentioned above. At the same time, the company does not expect to quit learning from others, find a final answer to low costs, or be relieved of mining problems by use of a new machine.



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By
RAYMOND E. SALVATI
President
Island Creek Coal Co.

American Mining Congress president looks for steady growth in coal production if industry is aggressive in holding present markets and diligent in developing new ones

BITUMINOUS COAL / The Next Five Years

BEFORE starting out on a journey, it is well to keep in mind where you're starting from. Similarly, before considering the next five years in the coal industry, it might be good to look around briefly and see where we are now and how we got here. This may be helpful to us in determining where we're heading.

The prospects for bituminous coal in the next five years will be largely governed by trends which are in existence at this time. It is no news to any coal man that there have been great changes in coal's markets since the end of World War II. Some changes are still taking place. Each fuel's share of the competitive energy market is changing, and changes are taking place in the uses for each fuel.

To see what has happened, let's examine for a moment some figures on the competitive use of fuels, ignoring such non-competitive uses as gasoline and lubricating oil. Between 1946 and 1958, our national energy requirements rose 22 percent, yet coal lost ground in this period. The demand for bituminous coal fell 27 percent in those 12 years, while the output of natural gas was rising by 237 percent and the production of oil was up almost 59 percent. This means that in 1946 bituminous coal supplied about 56 percent of the nation's competitive energy, but last year it contributed only one-third—though it still had the biggest share of all competitive fuels.

We all know of some of the changes in coal markets since 1946. The railroads have disappeared from the list of big coal consumers, and retail deliveries have slipped considerably. The use of coal for industrial steam has diminished. From 1946 to 1958, coal consumption in these three markets shrank by 213,000,000 tons, or about 40 percent of total 1946 production. The coal industry has been able to survive such a loss primarily because of the rapidly increasing use of coal by electric utilities and because of increases in the steel and export markets. Mechanization has improved production and helped keep prices down. Today, the utility industry is our number one customer, with steel in second place, and industrial steam ranking third. Now, where are we going?

We do have adequate coal reserves in the United States. The present potential operating capacity of the industry is approximately 600,000,000 to 650,000,000 tons a year. But, if we have a demand in the foreseeable future as high as 800,000,000 or 900,000,000 tons annually, it will be extremely difficult, irrespective of the great reserves which we have, to obtain that amount of coal at any reasonable cost. Capital costs for opening a new mine today are substantially above those of many mines now in operation.

** Based on speech presented at the 42nd Anniversary Convention of National Coal Association, Washington, D.C., June 4, 1959.*

Raymond E. Salvati, president, Island Creek Coal Co.; president, American Mining Congress, and a director and Executive Committee member, National Coal Association

1963 Production—500,000,000 Tons

Now let us estimate coal requirements for the next five years. First, we hopefully assume there will be no shooting war. I think we can also assume no real competition from nuclear power in this period; and for purposes of forecasting, we also assume there will be no major recession and that the cold war will continue at more or less the same pace.

Based on these assumptions, National Coal Association has prepared a forecast of the projected markets for bituminous coal through 1963. This is a prediction of coal consumption, but it seems logical that production will be at about the same figures.

The electric utility industry will continue to be the biggest customer of coal in the next five years. In fact, in 1963 it is expected to use 205,000,000 tons, an increase of about 34 percent over last year. This estimate is based on projections of kilowatt hour output made by the electric industry and by the Federal Power Commission. The forecast assumes a slight loss of the utility market to competing fuels and a continued increase in the efficiency of generating plants, which should produce one kilowatt hour from 0.86 lb of coal in 1963. It took 0.91 lb of coal to generate one kilowatt hour last year.

This is a conservative forecast of the coal market for electric utilities. Some persons in the electric power industry talk of duplicating the output in four to nine years, depending on the speed with which electric home heating is accepted. At any rate, the total of coal consumed by electric companies may increase much faster than we have forecast. They took about one-third of all bituminous coal produced in 1954. Last year their share had climbed to 37 percent. By 1963, electric utilities should burn about 45 percent of all bituminous coal produced.

Now for the steel industry, which was suffering last year because of the recession. To get a more accurate basis for figuring steel's increase in coal consumption for the next five years, we can average its 1954–1958 consumption. On this basis, the use of coal by the steel industry is expected to increase 13.5 percent by the end of 1963. Figured on last year's low consumption alone, the increase is almost 43 percent.

There has been a great deal of talk about processes for steel production which may eventually reduce the amount of coal used to make steel. In my opinion it will be many years before coke can be profitably replaced by any other method for making steel. We have a present steel capacity of 142,000,000 tons, but approximately all this capacity is tied to the use of coke, and it is my judgment that coke will be used in steel making for many years to come.

Now we come to the great "what-is-it" of the coal business—the many individual industries and user classes which are lumped together under the heading of "industrial steam." For lack of detailed data, it is hard to break down this catch-all category, which includes such users as cement manufacturers, textile mills, aluminum companies, and hundreds of other industries whose demands are not large enough to be listed separately in data collected by the Bureau of Mines. This group is strongly affected by the economic cycle. On our assumption that there will be no major recession in the next five years, put this class down for an increase of 13,000,000 tons—or 13 percent—through 1963.

Retail deliveries will probably continue to decline, though if it is any consolation, their decrease should be less rapid. In the last five years, retail coal sales have dropped more than one-third. In the next five years, this should slow down to a loss of 14.7 percent below 1958.

The export market is another hard one to forecast. The prohibitive tariff imposed by West Germany will cut back shipments somewhat this year. For the four following years we assume that overseas exports will run about 30,000,000 tons annually. This is a far cry from the big shipments of 1957, but still a respectable tonnage.

In Canada, increased subventions which favor consumption of Canadian coal reduced shipments of coal from the United States. The average of about 17,000,000 tons maintained during the last five years is expected to be only 14,000,000 tons in 1959. Looking at this market over the next five years, we can expect shipments to be somewhat larger in 1960, and then decline gradually to 12,000,000 tons.

Altogether, we foresee an estimated total demand of 500,000,000 tons of coal in 1963. This is a sound, conservative forecast, representing a respectable increase over production in 1958.

A Word of Caution

Coal has a sound future. Experts in many fields agree that the consumption of coal is sure to increase, not only in the next five years, but for decades beyond that. However, I would warn of two things:

First, this is only a paper forecast. It will not come true unless the coal industry aggressively fights off competition and develops each market to its utmost. Second, the predicted output in 1963 only brings us back to where we were in 1956. Obviously something is wrong if this can happen to a vital industry in our expanding economy. The coal industry has been suffering from restrictions and unfair competition which have hampered it severely. These handicaps must be removed if coal is to fulfill even this forecast, let alone exceed it.

For instance, we all know that coal markets along the East Coast have been hard hit by imported residual oil. The Administration order imposing mandatory restrictions on this foreign fuel is of some help, but it only reduces the imports to the 1957 level, when the tide of residual oil had already inflicted severe damage on the coal industry. Powerful interests are at work to remove even this small restriction. The coal industry must preserve the principle of making America dependent on its own fuel supply, not on foreign resources. It must use every opportunity to try to cut down further on the flow of residual oil.

A still larger problem is the dumping of natural gas in the industrial boiler fuel market. This practice squanders an important natural resource. It injures both coal and gas in their natural markets, the ones each is best fitted to serve. The coal industry must work for government policy

(*Continued on page 53*)

all roads lead to DENVER

AMC MINING CONVENTION PROGRAM OUTLINED

THE National Program Committee of the American Mining Congress met in Denver June 17 and reviewed hundreds of suggestions sent in by mineral producers all over the country. The Committee, under the direction of Ed Renouard of the Anaconda Co., selected a program for the September 14–17 Mining Convention to cover the most important subjects in mining today. Whether your main interests are in mineral policies, management, operating, milling or safety, you'll find topics right "down your alley" at the 1959 Convention.

Entertainment which you will long remember is also planned. A Welcoming Luncheon at noon and the famous Miners Jamboree—steak feed, floor show and dancing in the Trocadero Ballroom of the world-famous Elitch's Gardens—start the Convention in high gear on Monday. Tuesday and Wednesday feature special events for the ladies. The Annual Banquet, a speechless dinner followed by dancing until the early hours, will be the climaxing social event on Wednesday night.

For mining men, September will truly be a time when all roads lead to Denver. Don't miss this rare event where you can combine business with pleasure—successfully.

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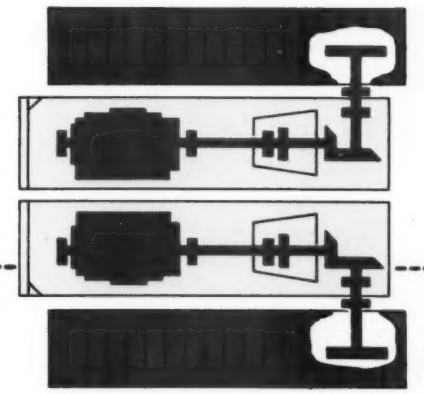
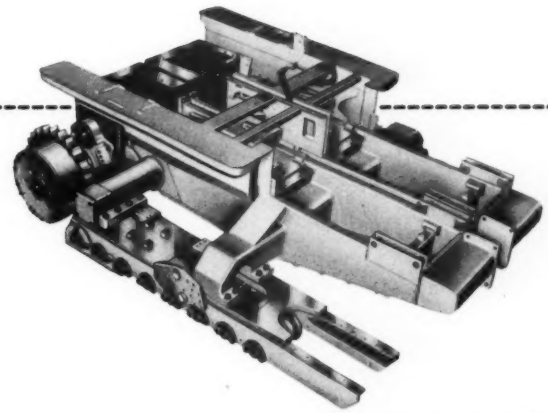


INDEPENDENT TRACK DRIVES Separate power trains provide individual control of speed, power and direction of each track. Spin turns can be made in its own length by simply reversing the direction of one track. Since only half of the total h.p. of the TC-12 can ever be applied to each track, there's no shock load in turning . . . less wear and tear on sprockets, tracks, rollers and other driving parts.



RIGID TRACK ALIGNMENT Each track is rigidly positioned to its main frame and is kept in constant alignment . . . a large diameter pivot shaft connects the two frames and permits free oscillation of each half for maximum traction on rough ground. Heavy track frames, just above ground level, add to stability and transfer shock loads to the rugged main frames. Longer track life, and resulting reduction of downtime and maintenance costs, are important advantages of constant correct track alignment.

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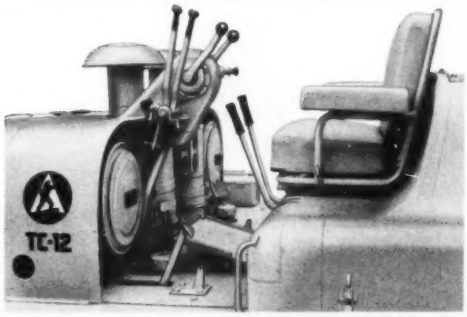

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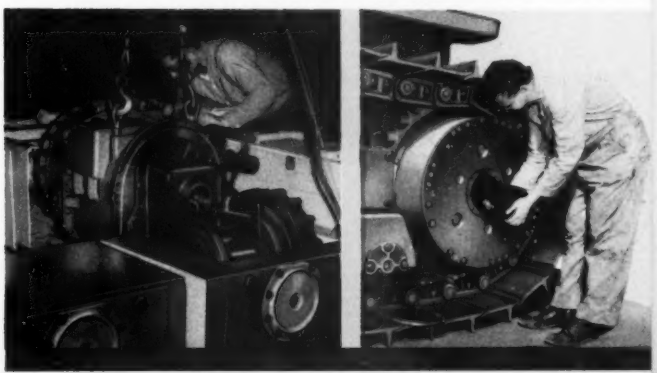

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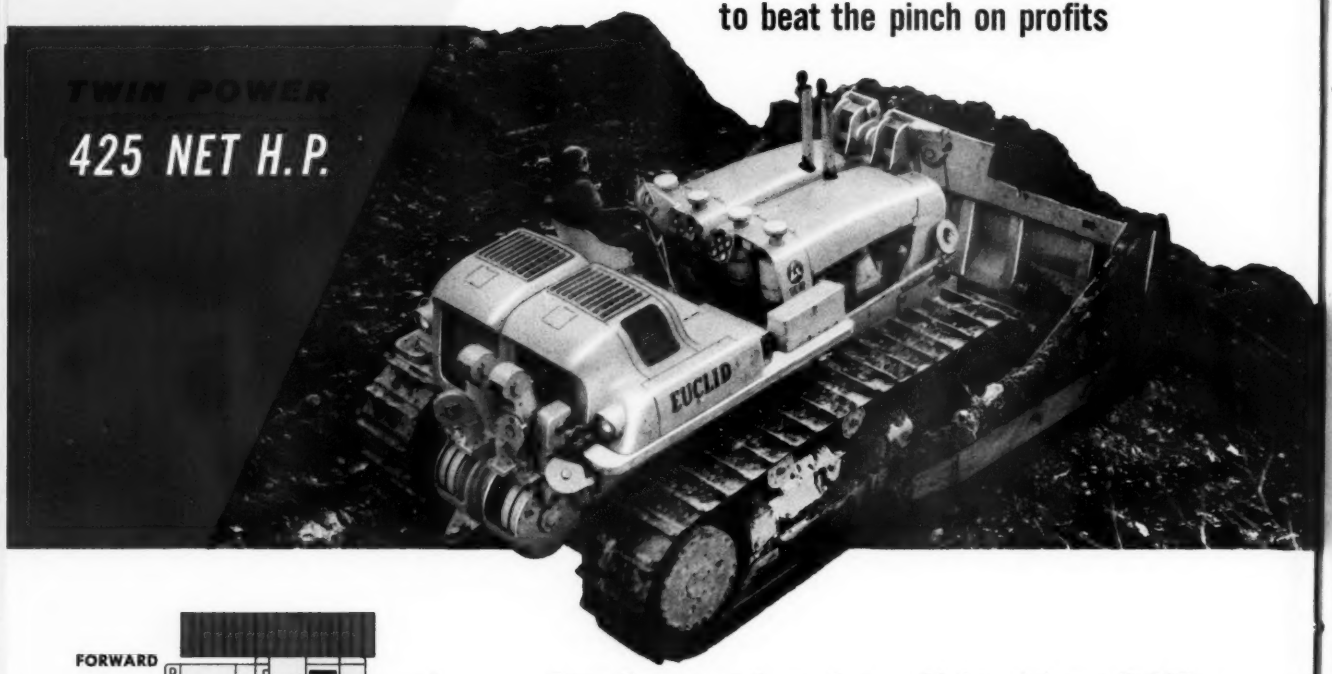
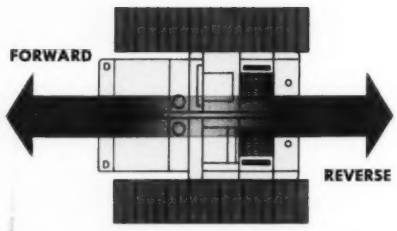
to beat the pinch on profits





NO CLUTCHING . . . NO STOPPING

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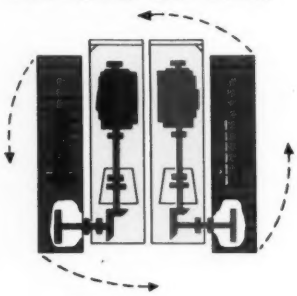

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By

S. E. JEROME

District Geologist
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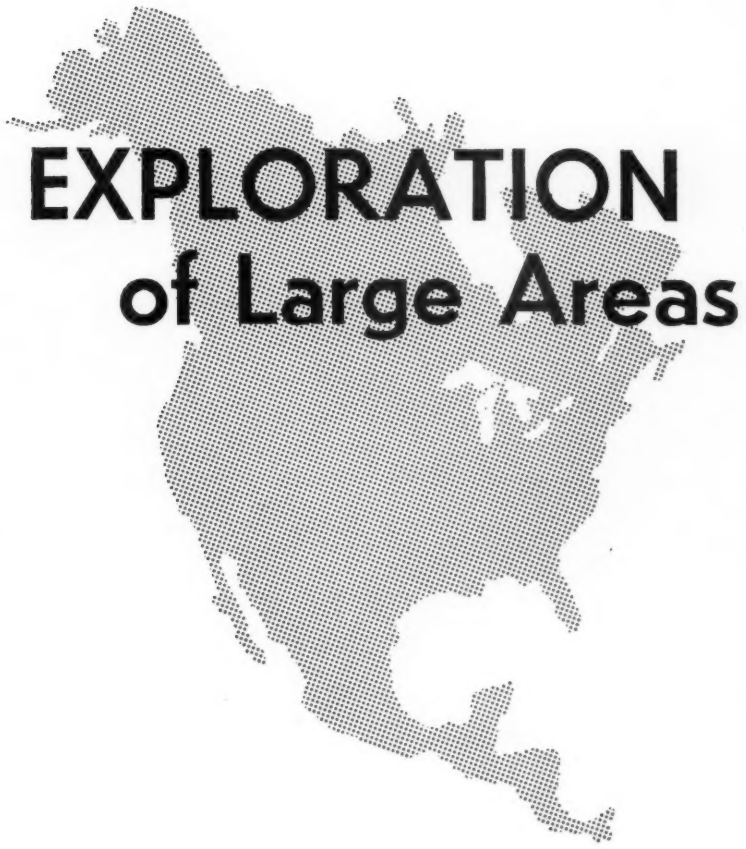
EXPLORATION of Large Areas



SINCE no restrictions have been imposed on the scope of the term "large area," this paper considers the problem of exploration for mineral resources on a continental basis and assumes the work is to be done by an organization initiating an exploration program. There may also be some thoughts of merit here that well established companies might adopt. Although certain parts of North America have been selected to illustrate some of the points involved, the general philosophy and procedures would be essentially the same anywhere. Enthusiasm for exploration and its practicability on some continents or in some countries is conditioned by political climate, tax policy and labor outlook; though recognizing the great importance of these and similar factors, this paper devotes no discussion to them but concentrates on procedures that can be used in finding new mining districts and new orebodies in old ones.

The exploration of large areas requires a substantial amount of planning, faith and persistence for the costs may be high and the time required to make a discovery quite long. The prime objective is with a minimum effort and expenditure to reduce large areas to much smaller, particularly interesting ones on which expensive personnel, tools and techniques can be concentrated with good chances of success. While an organization might be interested in any marketable commodity unique in size or quality, its exploration effort is likely to be less confused and more productive if some limit is set on the field to be covered. Herein discussion is restricted to metallic mineral commodities, although some of the methods reviewed apply equally as well to the exploration for non-metallics. It will be recognized that ample opportunity exists for specialization even in the fields of metallics, when the differing problems of exploration for ores of uranium, precious metals, base metals, iron and ferro-alloy metals are considered.

A two-stage process, outlined in table 1, is essential in selecting the areas ultimately to be investigated by drill, shaft or adit. In the first, or indirect, stage all of the facts are gathered on at least two map scales and preferably three, assimilated, imaginatively interpreted and projected. In the second, or direct, stage exploration methods and tools, carefully selected to fit the conditions, are employed. Constant research should be aimed at improving these methods and tools.

Where the facts are abundant as in well prospected and mapped areas, all of the steps suggested may be taken, but in little prospected areas where few if any facts are known, direct methods may be employed very early in the game. Thus, exploration might involve nothing more than the selection of large blocks of ground with favorable geology followed by airborne geophysical surveys, property acquisition and drilling. Another appraisal might involve only aerial reconnaissance, property acquisition and drilling. While such direct methods have their places, thorough exploration on a continental basis requires a more methodical approach. Many organizations are quite adept at quick examinations and in drilling properties which are brought to them, but they make little use of information gathering and map analysis to originate their own opportunities.

Stage One—Indirect Appraisal

Small Scale Geologic Maps: The initial step is to obtain the best available geological map of the continent. In the case of North America this is the 1946 edition compiled by George W. Stose at the scale of 1:5,000,000 and published by the

TABLE 1

STEPS IN THE EXPLORATION OF LARGE AREAS

The prime objective in exploration of large blocks of ground is to reduce them as quickly and cheaply as possible to much smaller, particularly interesting areas on which expensive personnel, tools and techniques can be concentrated with good chances of success. Beginning with an area such as the North American continent, this can be accomplished by a two-stage process.

Stage 1—Indirect Appraisal

A. 1: 5,000,000 or 1: 2,500,000 geologic, tectonic and commodity maps
   Selection of attractive regions
B. 1: 250,000 and 1: 62,500 maps of attractive regions
   - Geologic maps
   - Tectonic maps
   - Commodity maps
   - Photointerpretation
   - Geophysical maps
   - Geochemical maps
   - Property maps

Comparison of these maps will indicate areas of interest for which detailed compilations of all factual data are made at several scales on a transparent medium. These data are assimilated, imaginatively interpreted and projected.

Stage 2—Direct Appraisal

A. Observational and instrumental methods
   - Aerial reconnaissance
   - Prospecting and geologic work
   - Geochemical exploration
   - Aerial geophysical exploration
   - Ground geophysical exploration
   - Interpretation of results

B. Physical exploration methods
   - Drilling, driving and sinking

The exploration methods and tools listed above are carefully selected, considering the characteristics of the possible orebody, its environment and the problems of cover.

Geological Society of America. If for any reason a better map at the same scale is required, it must be compiled from modern information; but to attempt this is much too laborious a task for the likely rewards. The task of compilation, or recompilation, should be saved for smaller areas on which attention is to be concentrated. If the studies are to be restricted to one country or geologic province, obviously the initial map scale can be larger, say 1:2,500,000, and the detail of the geologic base vastly improved. Subdivision of the maps of the continent into major geological province sets may also be useful. These sets would include the Canadian Shield, Central Stable Region, Appalachian Mountain belt, western Cordilleran mountain belt and the Coastal Plain.

Small Scale Tectonic Maps: Since many geologic maps even of large scale do not show the structural picture adequately, a tectonic map should be compiled on matte or clear film to be laid over the geologic map. Several different tectonic sheets at the same scale may be necessary to bring out clearly the different periods of orogenic activity. A very useful supplementary overlay sheet is one showing intrusives of various types and ages. Tectonic maps for Canada, the United States and northern Mexico are available at different scales. The one for the United States is undergoing revision, as probably is the one for Canada. It will be helpful if some public-spirited group will combine and publish these as a tectonic map of North America.

Small Scale Commodity Maps: Commodity distribution maps are needed. Considering the many studies of mineral deposits of the United States by the government and other groups, it is surprising that, except for uranium, no mineral maps for the country as a whole are published at decent scales. The Canadians have done much better, but exploration in their country is proceeding at such a dynamic rate that their published mineral map does not show the major finds at Pine Point, Mystery-Moak Lake, Highland Valley, Mattagami, Mount Wright, Ungava, etc. However they have corrected this deficiency with the publication of *Minerals—Canada and the World*, a volume we in the United States would do well to emulate. Since knowing the position of new discoveries has considerable influence on ideas of where to explore, they should be added to the maps as rapidly as reported.

One composite map is desired showing the total distribution of a large number of metallics, but it should be meticulously assembled from sheets that show the distribution of only one commodity per sheet. All maps should be prepared on a transparent medium that will allow clear or matte acetate prints to be made.

These maps are so important that it may be desirable immediately to recompile them at larger scales so that no mineral locality is missed because of crowding at small scale. It is helpful to show new discoveries with no production with red circles and use black circles for camps for which production is recorded. So that the significance of productive localities can be compared, the dollar value of the combined past production and estimated future potential may be shown by different sizes of blacked-in circles. Another way of presenting the information is by ounces, pounds or tons of metal or tons of ore, but sometimes the data are inadequate to do this, and it is much easier to rate localities on a dollar basis. It is emphasized that these circles do not tell the whole story; they show only the pattern of known mineralization. A small past production does not mean that the future for that vicinity may not be brighter, and a complete lack of circles in parts of the north country or in the alluvium-covered areas of the Southwest does not mean these areas lack potential.

Selection of Attractive Regions: The commodity maps are laid over the geologic and tectonic maps and studied singly or in various combinations. Attention will immediately be drawn to certain regions because of geographic concentrations and relative value of the commodities themselves, prominent structural alignments that seem to influence these concentrations, and the presence of certain lithologies with which important deposits are associated.

Prominent examples of concentrations are the Juneau gold belt, base metal deposits of southern British Columbia and northern Washington, base metal deposits from Flin Flon to Moak Lake, varied base and precious metal deposits from Sudbury to Chibougamau, zinc in the southern Appalachians, Missouri lead belt, Tri-State lead and zinc, the Mother Lode

gold belt of California, the Foothill copper belt of California and the porphyry copper orebodies of the Southwest.

Probably the most obvious and striking examples of structural control are the Kirkland-Cadillac break and the faults that localize the Front Range mineral belt. Favorable lithologic situations are exemplified by the Precambrian, Ordovician and Silurian iron formations, greenstone belts in the Canadian Shield, conglomerates of the Blind River type, mafic flows and intrusives with which nickel and copper deposits may be associated as at Sudbury, anorthosites which may have attendant bodies of magnetite or titaniferous magnetite as exemplified by Allard Lake and Sanford Lake, limestones in many places with lead-zinc mineralization, Triassic basins with local limestone, mafic intrusives and iron-copper deposits, and clusters of intrusives of intermediate to salic composition with which many base and precious metal deposits are found. The list could be expanded.

Some aggressive groups might be content to proceed without further map work with exploration of some of the interesting situations outlined, but the target areas still are large and much readily available information remains to be collected and appraised. This preliminary stage of information gathering requires understanding and sympathetic managements; with some it takes considerable argument and persistence to get it done, and with some it never gets done.

Large Scale Map Studies of Attractive Regions: For those regions selected for detailed attention, the same three types of overlays discussed above are assembled at a much larger scale. The scale of 1:250,000 is an excellent one to sharpen the focus on more restricted, interesting situations within these regions, and maps for these situations in turn are assembled at 1:62,500 or even larger scales when the problem gets down to sharpshooting for single orebodies. During the preparation of these maps thorough literature studies are made and all properties in the areas of interest should be visited to learn the reasons for localization of individual orebodies and the districts that contain them.

All available air photographs are studied and a competent job of photointerpretation done. The photointerpretations only supplement the geological maps and should not be used in place of them except in emergencies. Their use without geologic control may introduce some misconceptions difficult to overcome later. Where aerial photographs are not available, the country should be flown. The United States is now covered by aerial photography, and the Canadians are making substantial strides in the same direction. In the United States, at least, some of the old photography contracted by the government during depression days is better replaced by new photography without further ado. Photomosaics are easily prepared and should be part of every photointerpretation job; they often are of tremendous help in calling attention to broad relationships that would otherwise go undetected. Under some circumstances infra-red and colored aerial photographs, though more expensive are much more desirable than those in black and white; this is especially true of any terrain with sparse vegetation.

The basic overlay set of geology, structure and commodity distribution is supplemented by all information likely to be useful in exploration that can be presented on maps. The final set of transparencies at the two scales above, 1:250,000 and 1:62,500 should include:

1. Detailed geology. Where gaps or inconsistencies exist, they should be filled in or corrected. Just because published maps may have been used in compilation does not mean they are correct.
2. Structures distinguished by age and contoured insofar as possible.
3. Intrusives distinguished by lithology and age.
4. Distribution of favorable lithologies whether source or host.
5. Metallization: orebodies, alteration, district zoning relationships, etc.
6. Commodity distribution with detailed production data.
7. Distribution and depth of post-ore cover.
8. Photointerpretation.
9. Geophysical data.
10. Geochemical data.
11. Property.

A final interpretative sheet is made, assembling all of the most critical facts and showing the projections of these facts leading to possible sites for undiscovered orebodies. It now remains to investigate them.

A major question by this time is, "What are the characteristics of the ore type and its environment that will influence the choice of methods to be used in narrowing the search?" A tool or method is desired that will always find ore directly, but in the present state of knowledge the explorer usually must be content with indirect indications. Of particular concern are the physical and chemical nature of the cover, its thickness, its age with respect to ore and its probable contrasts with the ore type sought. Some thought should be given to depth limits on economic exploration and exploitation of an orebody of a certain type, size and grade. Exploration men usually have crude ideas on this subject, but few have given it the serious thought it deserves. San Manuel, Ariz., will have some real lessons for those seeking porphyry copper deposits under substantial depths of cover.

It may be desirable at this point to secure interesting ground by staking, optioning or obtaining a concession; it depends on how competitive the situation is. If this permits continuing cooly and deliberately, relatively inexpensive, direct field methods may be applied that help to reduce the number and sizes of interesting situations as well as the headaches that commonly attend property acquisition.

Stage Two—Direct Appraisal

Aerial Reconnaissance: Aerial reconnaissance at varying altitudes and at different times of year with fixed-wing aircraft, supplemented with oblique black and white and color photographs taken with a hand-held camera help greatly in evaluating some of the impressions formed from the map work. The helicopter is a magnificent tool, for the air view can immediately be followed by inspection and sampling of interesting outcrops. As is well-known, however, its range is restricted and its cost and maintenance high. It supplements rather than replaces fixed-wing craft. It should be emphasized that it still is possible in slightly prospected areas, and to a lesser extent in well prospected ones, to make discoveries by direct observation from the air. Granduc in British Columbia is a fairly recent example of such a find. As long as such discoveries are possible, an air view by competent personnel with good reasons for being where they are ranks high on the list of things to be done very early in the direct appraisal stage.

Prospecting and Geologic Work: Prospectors and geologists are sent into the field to search for and examine outcrops and, in general, to sharpen the quality of the geological data. As a matter of fact, for some areas for which little of the information previously discussed is avail-

able, this may be the first step. In such cases the country is deliberately covered along grid lines cut out of the bush; while this may be somewhat slow and costly, it may be the only practical method. Where vegetation and soil cover is thick, shafts may be sunk to bed-rock at predetermined intervals to obtain the necessary geological information. Many areas have ants that may relieve the curse of their presence somewhat by bringing critical information to surface.

Geochemical Exploration: Geochemical exploration should be carried on by these advance ground crews. This is an effective, but not infallible, way of quite inexpensively appraising large blocks of ground for hidden base metal occurrences. Whether vegetation, rock, soil, stream silts or water are investigated separately or in combination depends on the geographical factors of climate, relief, nature of drainage, vegetation, soil cover, etc.; the field and laboratory techniques must be designed with all of these in mind. Thick, widespread, post-ore cover often presents an insoluble problem to the exploration geochemist.

Aerial Geophysical Exploration: In areas of only modest relief known to contain relatively unoxidized massive sulphide orebodies under shallow cover, a most ingenious modern approach is to use an aircraft equipped with geophysical instruments capable of measuring total magnetic intensity, electro-magnetic response and radioactivity and capable of taking photographs for location purposes at the same time. Of course, all such measurements can be made singly from the air; it depends on the objectives, but it is desirable to obtain all possible data from a single flight. This equipment has been used extensively and successfully in the Canadian Shield and the northern Appalachians, but to date has not been used in a broad way in the United States and Mexico.

The United States Geological Survey has flown some test areas which have proven the usefulness of the aeromagnetometer for locating magnetite deposits, certain sulphide orebodies, certain types of intrusives and for disclosing structures. The Canadian Geological Survey is covering large areas with the airborne magnetometer. Staking rushes commonly follow publication of its maps, particularly after the somewhat lackadaisical way in which they were greeted before the first major discovery in New Brunswick. Private organizations have extended the work of the two governments and certainly have proven the value of the airborne magnetometer in locating magnetic iron deposits and formations under substantial thicknesses of cover. The discoveries at Marmora, Ontario and near Morgantown, Pa., are two striking examples. In other situations the aeromagnetometer is only a tool giving highly useful results that supplement other kinds of data.

Gravity measurements are being made from aircraft, but this writer is not informed whether the results are really useful in the search for ore deposits.

Since it is possible to accumulate large bills fast by aerial methods, the need for careful selection of ground to be flown is emphasized again.

Ground Geophysical Exploration: The anomalies that appear on maps after air coverage may be staked or optioned, prospected and drilled. In the case of most strongly backed and well considered programs a more deliberate approach is taken. The ground is staked, prospected, mapped, explored by geochemical and geophysical methods and then rejected or drilled. Again, the detailed ground work is designed with the characteristics of the possible orebody, its environment and the amount of cover in mind.

The ground magnetometer has similar attributes to one carried by planes, but results are more confused by surface hash. A variety of electrical methods may be useful in seeking sulphide orebodies. While self-potential and equi-potential methods have been of great value locally, the electromagnetic methods applied both from the air and on the ground enjoy the greatest popularity and success today in detecting massive sulphide orebodies at relatively shallow depths. Self-potential and pulse methods are promising for measuring amounts of disseminated sulphides even at fairly substantial depths. An exciting new geophysical method, AFMAG, also promises to be useful for both large scale and detailed appraisals.

Interpretation of Results: Interpretational problems are introduced into geophysical results by water-saturated clays, salt-bearing waters and carbonaceous beds, etc. Under these interfering circumstances a combination of geology, geochemistry, magnetics, electromagnetics and gravity may serve to separate potentially productive from nonproductive anomalies. Certainly, if anomalies resulting from three or four of these methods which measure different characteristics coincide spatially, adequate reason exists for drilling. Some may feel that all this is much too costly additional work, but if the area is large and the targets many, it is sensible to screen the anomalies resulting from aerial geophysical surveys by detailed ground studies.

Some situations because of rugged terrain, depth of oxidation and thick cover are impossible geophysically. In such cases if geological reasons are compelling, proceed with drilling, driving or sinking; it is foolish to use geophysics just because it is popular. It should be remembered too that whenever geophysics or geochemistry are used and results are negative, a prospect may still deserve to be tested for geological reasons. A strong tendency exists on the part of some geologists either not to use these methods at all or to use them as crutches and either turn a prospect down because of unfavorable geophysical or geochemical results or blame them if no ore is found. These methods supplement geological thinking; they do not replace it. If no ore is found it may be entirely the geologist's responsibility for poor selection of ground in the first place.

Summary

To summarize: Collect the facts and appraise them. Select the interesting areas for concentrated attention. Make detailed literature and map studies of these areas followed by intelligent projection. Design the direct exploration effort with the nature of the orebody and its environment in mind. If the right amount of luck blends with science, and tools do not become dull through lack of research, it should be possible on any continent to make many important new discoveries following the procedures outlined above.

"Remember that four-bit raise the boss promised me?"

Coal Transportation

FROM CONTINUOUS MINING EQUIPMENT

Here is how a leading coal producer is attacking the problem of haulage behind continuous mining equipment. To date, shuttle cars have proved the most reliable. However, recent developments in extensible conveyors point to their great potential

By

BRUCE E. DUKE
Assistant to the Manager
Bethlehem Mines Corp.

FOR many years the coal industry has been deeply interested in haulage with continuous mining equipment. This article will describe the experience of Bethlehem Mines Corp. with different types of continuous haulage equipment.

Approximately 50 percent of Bethlehem's production is produced with several types of continuous mining machines, in many different coal seams under varying mining conditions. The company recognizes that to have only a continuous mining machine is not the answer to continuous operation. Eventually a method must be obtained to take coal away from the machine without interruption, thereby producing high tons per man and low costs, whether the mine is large or small.

Bethlehem's ultimate goal is to have a completely continuous mining system. Elimination of shuttle cars is a general objective. The use of shuttle cars will never provide a continuous system. However, the company hauls, by far, the greatest percentage of coal away from its continuous mining machines with shuttle cars. To date they have proved to be the most reliable with their flexibility. Use of shuttle cars has fulfilled a necessary step in the progress toward a continuous system.

The company believes that conveyors of some sort are the most logical means for hauling coal away from continuous mining machines with or without bridge devices.

Mobile Conveyor Has Good Possibilities

Prior to 1951 when Bethlehem decided to experiment with continuous haulage systems, engineers in one of its low-coal divisions listed the advantages and disadvantages of the three basic systems believed feasible at the time. Included were (1) shuttle cars, (2) extensible belt and (3) mobile or cascading conveyor.

Time studies in one of the company's low-coal mines (Lower Kittanning seam) showed that a continuous mining machine with two shuttle cars, at 2.18 tons per shuttle car, using two runways with room lengths of 350 ft, could utilize only one-half or less of the available working time to mine coal.

Estimates were made of the time consumed at the face when using extensible belts. They were: loading time 69 percent, maneuver time seven percent and delay time 24 percent, including 30 minutes for extending the belt. Management believed that it would gain production by using an extensible belt instead of shuttle cars, especially on steep grades.

Bethlehem's first experience with a continuous-type haulage unit behind a continuous mining machine was with a cascading or mobile conveyor. In March 1951 a mobile conveyor was received for use in one of the company's thin-seam mines (42-in. coal) for trial and development purposes.

At that time, time studies were made of the mobile conveyor transporting coal from a continuous mining machine in entry work (see figure 1). This was compared with the same type machine in room work, using shuttle cars to transport the coal. Delivery in both cases was to a conveyor belt in the entry. The mobile conveyor, in conjunction with the continuous mining machine, was used in the development of three entries with centers on 60 ft and with crosscuts driven at 45° angles. Effective

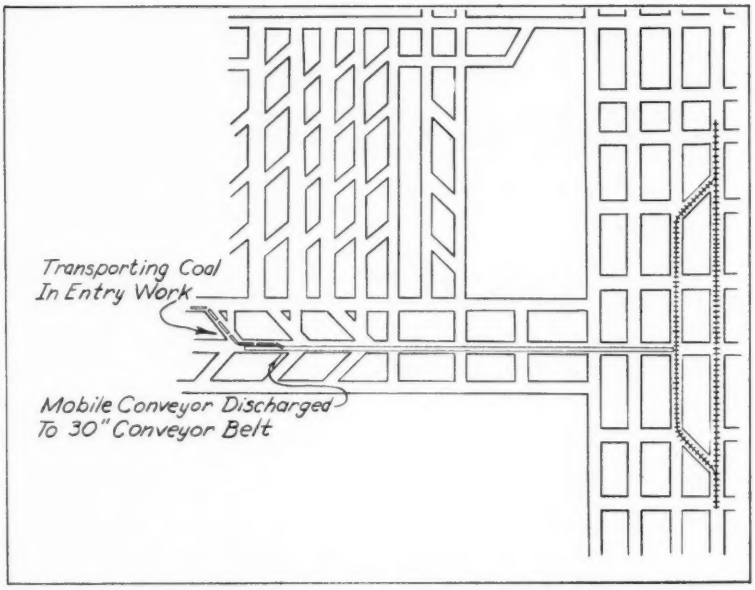


Fig. 1. Thin-seam experiment with a continuous-type haulage unit behind a continuous mining machine. A principal advantage inherent in the mobile conveyor is its ability to follow the continuous mining machine wherever it goes

length of the mobile conveyor was only 155 ft, which limited the flexibility needed for an orderly mining plan.

Based on the time studies, the mobile conveyor is believed to have good possibilities for hauling coal away from continuous mining machines. A principal advantage inherent in the mobile conveyor is its ability to follow the continuous mining machine wherever it goes and also to retract with the machine.

Much of the company's trouble at the time was in the operation of the continuous mining machine, although there were difficulties and many delays due to the mobile conveyor. Good performance with the mobile conveyor and continuous mining machine combination lasted for only short periods, when coal was mined and conveyed at the rate of 2.19 tpm. The mobile conveyor proved its value to the extent that there were some periods that it enabled the continuous mining machine to work continuously.

The operating people of the division were enthused to the degree where they believed that they should achieve continuous operation in the neighborhood of 71 percent of available working time by use of the mobile conveyor. This might have been optimistic. However, due to the high cost of the mobile conveyor, and unsolved difficulties with the experimental unit, its purchase could not be justified at that time.

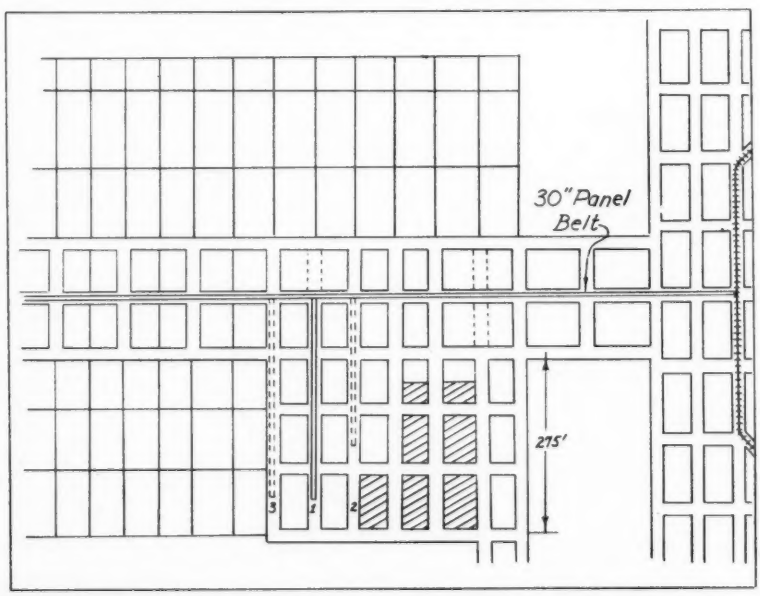


Fig. 2. Bethlehem's half-advance, half-retreat system of mining with an extensible belt and bridge haulage unit behind a continuous mining machine. A major problem was the three to four-hour delay in moving the belt to the face of the previously driven room for pillaring

Extensible Belt and Bridge Tried—Hitching Had to Be Revised

Bethlehem's first experience with an extensible belt and bridge haulage unit behind a continuous mining machine started in October 1955. Prior to this, in the same mine where the mobile convevor was tried, the company began to approach steep grades on the eastern slope of the Laurel Ridge Anticline. Grades ranged from five to seventeen percent to the rise. Rubber-tired shuttle cars were not satisfactory for operating on the more severe grades and side pitches. It was believed that the extensible belt could operate successfully in longer room panels and on the steeper grades where shuttle cars have definite limitations.

The extensible belt conveyor selected was 30 in. wide, with extension to 300 ft. Drive was crawler-mounted with a built-in belt-storage section capable of storing 100 ft of belt. Tail section was crawler-mounted and fitted with a bridge conveyor 20 ft in length. The belt was made reversible.

Extensible belt was limited at first, as far as the bridge was concerned, by sudden grade changes in the places. When it was first put into operation, the hitching, which connects the bridge to the continuous mining machine, was too close to the bottom and the bridge was too straight. The continuous mining machine broke the hitching in maneuvering in loose bottom material. Mine maintenance personnel revised the hitching with some success.

Greatest Delay Was in Moving

At first the system of mining was to advance one room parallel to a room that had already been driven, and then retreat the equipment, which required three to four hours delay in

moving the extensible belt to the face of the previously driven room for pillaring (see figure 2). Since it became necessary to have one room open for escapeway and air, while the adjoining room was pillared, and as the mine had only one extensible belt, a system was adopted whereby two rooms were advanced and retreated concurrently. The continuous mining machine would advance one room a crosscut length with shuttle cars, dump onto the extensible belt, and then advance the other room with the conveyor attached to the machine. This eliminated the three or four hour delay for moving the extensible to a new set-up. The mine had to have a shuttle car and an extra operator in the section to do this.

The greatest difficulty with this particular extensible conveyor was the delay in moving it from room to room. Management thought of a few ways to meet this problem. One, it considered buying additional belt and frames so that intermediate sections of the conveyor could be left in one room, while the head and tail sections were moved to the adjoining room, to connect with the intermediate sections which were left when that room was driven. This should cut the delay in half. Two, the mine could drive two adjoining rooms, advancing and retreating them simultaneously, with two continuous mining machines and two extensibles. This method, with a room 500 to 600 ft in length, would reduce the delay to about one hour for every 30 shifts. However, this would create a problem of equipment storage in very limited space at the outby end of the rooms.

Management operated the extensible in 350-ft rooms with varying degrees of success. Late in 1955, when the extensible belt and continuous mining machine combination was tried for a one month period in a production heading, the performance averaged 163 tons per shift in advance work, and 149 tons per shift in pillaring. This resulted in 27 tons and 25 tons per man shift, respectively. The extensible belt and continuous mining unit were situated in a production heading with improved conditions because of a change to a mining method of full retreat (see figure 3). In mining on a full retreat basis, which was discovered to be the most successful, performance averaged 233 tons per shift or 39 tons per man for a two-week period. Incidentally, during one complete day the continuous mining machine and extensible belt were on advance of a room (17 ft wide by 350 ft long) for the entire day, producing 985 tons, including time for preparation to move to another room during the day. For this day, the performance was 55 tons per man in 42 in. of coal. However, for the five month period November 1956 through March 1957, the continuous mining machine and extensible belt combination produced only 27 tons per man, only a slight gain over shuttle cars.

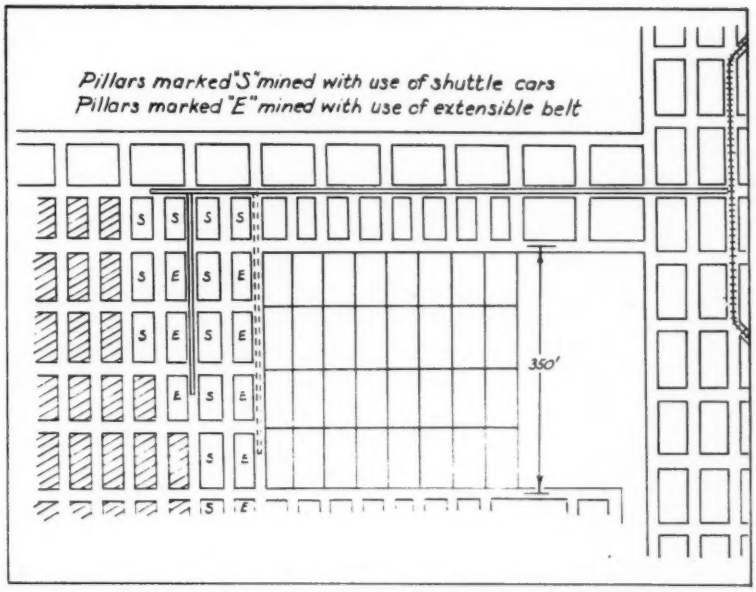


Fig. 3. In mining on a full retreat basis with an extensible belt, performance averaged 39 tons per man for a two-week period

Since June 1958 the extensible belt has not been used. The primary reasons for this have been the discouragement of the mine personnel in the operation of the bridge conveyor, the

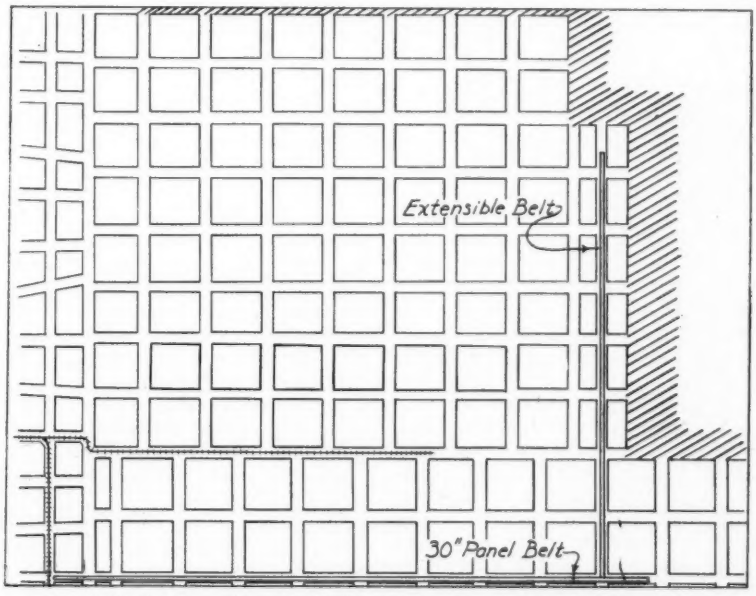


Fig. 4. Block system. The extensible belt is set up in such a way that the continuous mining machine and extensible belt mine through developed blocks, splitting them. In pillaring, the initial plan was to take alternate open-end lifts off the pillar, first from one side and then from the other side of the center primary split. Considerable difficulty was experienced and it was decided to mine only the right hand half-block with the extensible belt and bridge attached to the continuous mining machine. The left hand half-block was mined with a loading machine and shuttle cars behind the continuous mining machine. Success has been limited

excessive time required to move the extensible belt from the face of a developed room to the face of a room ready for pillaring, and the failure of the belt-reversing mechanism, which necessitated an extra man to handle supplies.

Bethlehem's first experience in low coal left it with misgivings. Management believed it was not successful, but it was attempting to go in the direction of progress.

Pillaring With Extensible Belt, Continuous Mining Machine

In February 1959 the company started operating a continuous-type haulage unit with a continuous mining machine in coal 60 in. high. The haulage unit is an extensible conveyor with a belt 30 in. wide. It will extend to 1000 ft, has a crawler-mounted head section, crawler-mounted tail section, 200 ft of belt storage, and a bridge 24 ft long.

Before the use of the extensible belt, an area was developed, on the block system, for use with the belt (see figure 4). The extensible belt discharges to a regular panel belt 30 in. wide. The extensible belt is set up in such a way that the continuous mining machine and extensible belt mine through developed blocks, splitting them. The primary split, 18 ft wide, is made through eight blocks for a distance of 635 ft. At the far end of the primary split, the end of the continuous mining machine is about 835 ft from the regular panel belt.

The company had great difficulty in making the primary split as the extensible belt tail piece would climb onto a windrow of loose coal left near the center of the split by the continuous mining machine. As it climbs onto the windrow, the tail piece tilts and binds the bridge conveyor. So much production was lost in this manner that management reverted to loading-machine pick-up and dumping into a shuttle car for short haulage to the bridge conveyor. In this way the primary split was finished.

Attempts were made to pillar with the extensible belt and bridge attached to the continuous mining machine. The plan was to take alternate open-end lifts off the pillar, first from one side and then from the other side of the center primary split. Coal from this mine is usually very hard. The continuous mining machine had insufficient space in the primary 18-ft wide split to turn at right angles, and would not make curved penetration. The result was about 60° to 70° angled splits off the back of the half-blocks on either side. This left many small irregular stumps which could not be mined and were lost.

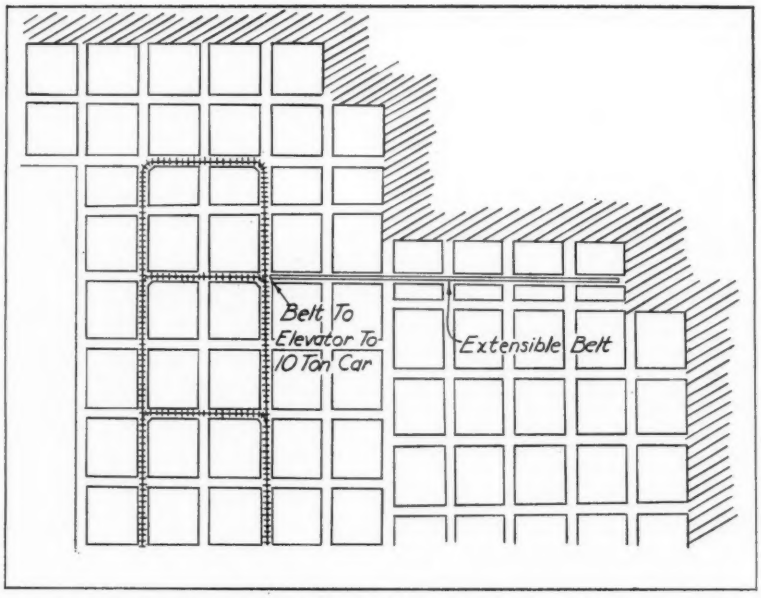


Fig. 5. Roof conditions required the row of blocks at this mine to be split ten ft off center — the largest portion of the block being on the side toward the gob. See figure 6 for method of pillaring

It was then decided to mine only the right hand half-block with the extensible belt and bridge attached to the continuous mining machine, and mine the left hand half-block with a loading machine and shuttle cars behind the continuous mining machine, coming around from the solid coal side of the left-hand half-block. The shuttle cars dumped onto the end of the bridge which rested on the bottom. The tail piece was, of course, retracted to a crosscut where the shuttle car route would be safe, but as short as possible. Success has been limited.

At the time of this writing, performance has not been good. Use of the bridge and extensible belt in any combination tried has not produced nearly the tonnage of coal obtained by using two shuttle cars behind the continuous mining machine. However, improvement seems apparent because, during one try of pillaring, the continuous mining machine, working 53 percent of the available work time, mined 324 tons at 54 tons per man.

Best Performance Was 91 Tons Per Man

In February 1959 Bethlehem started operating a continuous-type haulage unit with a continuous mining machine in coal 84 in. high. The haulage unit is an extensible conveyor with a belt 36 in. wide. It will extend to 600 ft, has a crawler-mounted head section with 40-hp belt drive motor and crawler-mounted tail section. It has 200 ft of belt storage and a straight bridge 26 ft long. The extensible discharges into an elevating chain conveyor flared for a slight surge capacity. Then the coal is discharged into ten-ton mine cars. The slight surge capacity of the elevating conveyor allows time for moving up an empty car by room hoist.

Before the use of the extensible belt an area was developed on the block system, for use with the extensible belt in conjunction with a continuous mining machine (see figure 5). The extensible is set up in such a way that the continuous mining machine with extensible belt splits through a series of blocks. The row of blocks at this mine are split ten ft off center for various reasons believed good for roof control, the largest portion of the block being on the side toward the gob. The primary split, 13 ft wide, is made through four blocks for a distance of 340 ft. At the far end of the primary split, the end of the continuous mining machine is about 530 ft from the track where the coal is loaded into the ten-ton cars.

Bethlehem has been successful in making the primary splits at this mine. To date, pillaring of the split

(*Continued on page 56*)

In little more than ten years, drilling and blasting have advanced markedly in the copper districts of the Southwest. Cumbersome churn drills which slowly pounded a nine-in. hole into the ground have been replaced by highly efficient, 12-in. diameter rotary drills. Drilling rates have increased over 2½ times, and costs have been cut by one-third

LARGE Diameter Blast Holes

By

JOHN A. LENTZ, JR.

General Superintendent
Morenci Branch
Phelps Dodge Corp.

More than 700,000,000 tons of rock have been removed from the Morenci pit to date. At this widest point, the pit is 1½ miles across. The present mining rate is 160,000 tons per day

TO most mine operators in the Southwest who are engaged in open pit mining of the porphyry coppers, the term, "large diameter blast holes", now means vertical holes from 9 to 12 in. in diameter. Little more than 10 years ago the largest size in common use was nine in., at which time the churn drill was almost universally used for drilling blast holes of this diameter. Then, larger churn drills capable of swinging 6000 lb of tools became available, and some operations were converted to 12-in. hole drilling. Rotary drills, using compressed air for removal of cuttings, were subsequently introduced in the fall of 1950. The rapid development of these machines has now resulted in the replacement of churn drills in most open pit mines of the Southwest and many other areas.

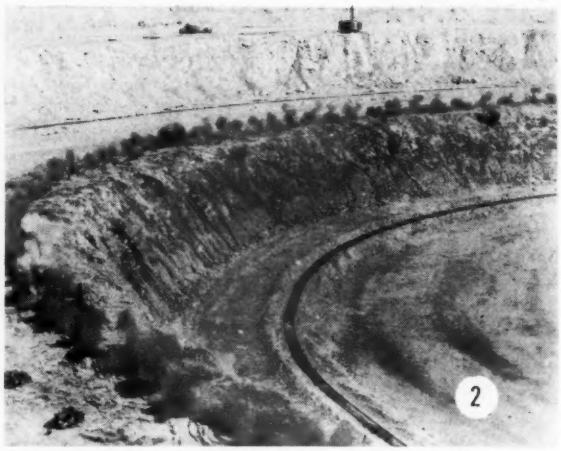
At the Morenci Branch of Phelps Dodge Corp., conversion from nine-in. to 12 in. churn drill holes was started in 1948, and conversion from churn drills to rotary drills for the drilling of 12-in. holes has just recently been completed. Although most open pit operators in the Southwest have now turned to rotary drilling, only a few are using the largest available drills and bit sizes. The Morenci (and elsewhere similar) experience may therefore be of some interest to those who may still be considering the relative merits of, say, nine-in. and 12-in. holes.

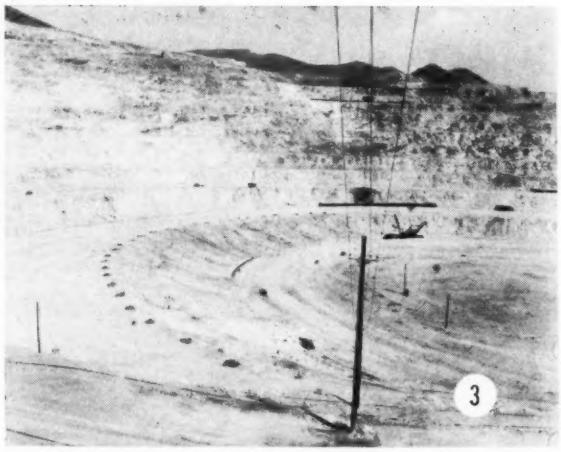
Morenci Drilling and Blasting Conditions

The Morenci pit is well developed, having had approximately 700,000,000 tons of rock removed to date. The maximum rim to rim dimension is approximately 1½ miles. Twenty-seven levels or benches have been established at intervals of 50 ft. Most of the benches are of such length that it is possible to break an average of 270,000 tons of rock per blast. The present mining rate is approximately 160,000 tpd.

Although there are several rock types that fall within the mining limits including granite, limestone, shale and quartzite, the great majority of the work is conducted in rocks classified as quartz monzonite porphyry and granite porphyry. The porphyry formations are brittle and have closely spaced shatter cracks that promote good fragmentation. Generally speaking, these predominant rock types could be classed as of medium hardness in comparison with those of other porphyry copper deposits.

Loading is done with electric shovels of from six to nine-cu yd dipper capacity. Haulage equipment includes 40-cu yd side dump cars and





Blast sequence. Explosive being loaded (1); blast just after detonation (2) and broken material after blast (3)

some single rear axle trucks of 25 and 35-ton capacity. Boulders too large to handle with this equipment are rarely encountered in the porphyry areas, and secondary blasting is a minor item.

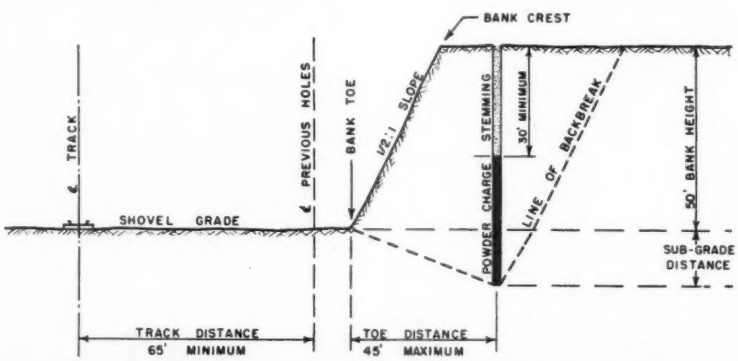
A typical bank face, after shovel clean-up, will stand at a slope of ½ to 1 or slightly flatter. Large drills can ordinarily be set up a safe distance from the "crest" or edge of a bank without exceeding a "toe distance" of 45 ft. (See drawing of typical blast section). If the toe distance is kept within proper limits and the track below is at standard distance, the banks can be blasted without removing the track, and a full muck pile is provided which can be cleaned up in two shovel cuts.

Design of 12-Inch Blast Hole Pattern

The prime objective when considering any given type of drill hole for blasting is to minimize the combined drilling, blasting, shoveling and track moving costs per ton of rock broken. In the porphyry formations described, it has been found that good fragmentation is not difficult to obtain through use of any one of a number of blast hole patterns. The following discussion relates particularly to this type of ground as opposed to rock that tends to break in large blocks or situations where back-break is difficult to control.

From the standpoint of "powder efficiency" (tons broken per lb of explosive), it is advantageous to use a single line of drill roles rather than multiple rows because all holes are then breaking to a "free face." It has also been demonstrated by others, in carefully controlled tests with properly placed explosive charges, that powder efficiency decreases as the toe distance is increased. This dictates that the toe distance should be held to the practical minimum if increased explosive costs are to be avoided. Fortunately, in the drilling and basting of the 50-ft high banks at Morenci, adherence to the minimum toe distance required for safely setting up large drills generally results in a muck pile that provides close to minimum shoveling and track costs.

In practice, the number of cu yd of "burden" on each hole and above shovel grade is estimated before explosives are loaded. This figure in conjunction with a "powder factor" (lb of explosive per cu yd of burden) determines the actual charge. The powder factor is assumed to vary only with the character of the rock



Typical blast section. Large drills ordinarily can be set up a safe distance from the crest without exceeding a toe distance of 45 ft. Banks can be blasted without removing the track

Conversion from nine-in. to 12-in. churn drills was started in 1948, and conversion from churn drills to 12-in. rotary drills (above) has just recently been completed

being blasted, and once a standard blast hole pattern has been established it is a convenient guide for determining the charge for each hole. However, for purposes of initial design the burden below shovel grade should also be considered since this material must be moved. Also, in addition to the effect that the toe distance has on the powder factor, the possible influence of the position of the explosives in the drill hole must be recognized.

In considering the efficient utilization of drill holes, it is apparent that the increased explosive capacity of 12-in. holes, as compared to nine-in. holes, may be used to advantage in two ways; i.e., the toe distance may be increased and/or the interval between holes may be increased to obtain an increased amount of broken material per ft of drill hole. However, if the toe distance is increased appreciably, increased explosive costs and increased track moving costs would tend to offset the saving in drill holes. For this reason it is logical that the possibility of increasing the space of the holes should be examined first.

During the period that nine-in. holes were in use, the standard spacing was 18 ft and holes were drilled approximately 10 ft below shovel grade. When 12-in. holes came into use, it was possible to increase the spacing to 24 ft without making any significant change in either the depth of drill holes or the average toe distance, which remained at approximately 40 ft. Powder efficiencies continued to be the same in areas of equivalent hardness, the over-all average being approximately five tons broken per lb of powder used. In the type of material under discussion, the increased hole spacing resulted in an improvement in tons broken per ft of hole from a figure of approximately 60 for 9-in. holes to 83 for 12-in. holes—an increase of 38 percent. More recently, a further improvement in this factor has been obtained through making additional changes in the placing of the 12-in. blast holes in an effort to further reduce drilling costs. Some of the principal considerations leading to the adoption of the present patterns will be discussed.

An important factor in minimizing drilling cost is to load as much explosive as can be effectively used into each drill hole. With a 12-in. diam hole it has been found that 30 ft of stemming will safely confine a column charge which fills the lower portion of the hole. Since the rise of explosives in 12-in. holes is approximately one ft per 50-lb case, a charge of 1500 lb can be safely loaded into a 60-ft hole. If the toe distance is maintained as previously described, hole spacing could theoretically be increased to 38 ft, assuming that powder efficiency would not be adversely affected by the increased width of the burden and the position of the added charge. That is because the maximum individual charge at 24-ft spacing rarely exceeded 950 lb. However, in considering a radical increase in spacing, two questions arose:

1. Would a uniform back-break occur between holes so that the bank would not emerge with unusual irregularities?

2. Would "hard bottom" be encountered in the area between drill holes?

With respect to the first question it has been found that the use of hole spacings up to 42 ft does not result in any change in the appearance of the faced-up banks; that spacing represents a ratio to average toe distance of 1.05 to 1. Although different rock types are involved, it may be noted that many quarries successfully use the "elongated" pattern with ratios as high as 1½ to 1. In the Phelps Dodge pit at Ajo, ratios as high as 1 1/3 to 1 have been used, with the same favorable results, in the blasting of 40-ft high banks in monzonite porphyry. In answer to the second question, it has been found that hard bottom can be avoided by drilling 15 ft below shovel grade instead of 10 ft.

The extra five ft of drilling yields additional hole space which is available for explosives. On the other hand there is some increase in the actual cu yd of burden on the hole (below shovel grade) which must be moved. For equal drill hole spacing this increase of five ft in hole depth increases the *total* burden on each hole by approximately seven percent. However, the amount of explosive which may be loaded into an individual hole can be increased from 1500 to 1750 lb—an increase of 17 percent. That would warrant an increase in drill hole spacing to approximately 42 ft, providing the position of the additional charge in the hole does not reduce its effectiveness.

An interval of 42 ft between drill holes 65 ft in depth was adopted for trial use in areas where a powder factor of 0.75 was indicated. This proved to give excellent results and became the standard for this type of ground. Use of this pattern has resulted in the breaking of approximately 132 tons of material per foot of drill hole. In areas of harder rock, where higher powder factors are required, the spacing is reduced, but the depth of the individual blast holes is not changed. For example, where the indicated powder factor is 0.90, the spacing is reduced to 35 ft, which, of course, results in a corresponding reduction in tons broken per foot of drill hole. The use of these patterns requires that the drilling and blasting foreman determine what powder factor or factors are to be used before drilling is started. The factors in common use at Morenci range from 0.70 to 1.00.

Although it could be expected that powder efficiencies might be somewhat lower than were obtained with the more conventional patterns due to the added burden below shovel grade and the positioning of the explosive charges, the results to date show no significant change. In any event, it would require a drastic reduction in powder efficiency to offset the saving in drilling costs.

Drilling of 12-Inch Blast Holes

The principal features of the new rotary drills and their application in numerous open pit operations throughout the country have been well described in articles appearing in the technical press over the past several years. Rotary drilling rates ranging from two to seven times those of churn drills have been claimed. Reported costs per ft of hole have invariably been less than churn drilling costs, and in some cases they are as low as one-fourth of the operator's previous churn drilling costs. These data emphasize the fact that there is no simple rule of thumb to accurately predict the performance of a rotary drill from the results which have been obtained with churn drills.

Although drilling costs per ton of material broken at Morenci had been reasonably low while using 12-in. churn drill holes, the prospect of further improving drilling efficiencies and costs through the use of large rotary drills was attractive. One rotary drill equipped for drilling with a 12¼-in. Tricone bit was therefore purchased in late 1956 and put into trial service. Provision was made for injection of a small amount of water into the air stream going down the hole for dust control purposes in preference to using a dry type dust collector.

During the trial period of approximately 10 months, it was found that the rate of drilling per shift was 2.6 times that of churn drills and the indicated cost per foot of hole was two-thirds of the corresponding cost for churn drill holes. With only one rotary drill in operation, it could be assigned to the areas that were most favorable to uninterrupted drilling. Long drill moves occurred relatively infrequently, and the drill worked over 80 per cent of the available time. It was recognized, however, that if additional rotary units were put into service, moving time would become increasingly important. The overall rotary drill availability could drop appreciably as churn drills were progressively replaced in areas where working faces were shorter. A careful consideration of the problem of frequent long drill moves and the desire to protect against extensive outages of a drill unit indicated the need for seven units if conversion were to be complete.

Drilling efficiencies during the first half of 1958 were better than during the trial period in 1957. This is gratifying in view of the fact that it was necessary to train churn drill operators and helpers to operate the new rotaries as they were put into service. Set forth below are the principal statistics relating to rotary drilling for the first half of 1958:

Total feet drilled	**79,783**
Feet per drill shift	**290**
Feet per bit (12¼-in.)	**1662**

Rates of penetration have varied from 30 to 90 ft per hr. The average figure of 290 ft per drill-shift corresponds to a penetration rate of about 56 ft per hr. Table 1 lists the average delays that occur and shows the effect of varying penetration rates on the average efficiency in feet per drill-shift.

Aside from the saving in the cost of drilling a foot of hole, the use of rotary drills has been of benefit to operations other than drilling. Following are listed some of these additional advantages:

1. A drier hole is produced. Excluding drilling below the pit bottom, where all holes tend to fill with water, churn drill holes usually contained from one to five ft of water and sometimes more. This required the use of large amounts of the gelatin dynamites.
2. Rotary drill holes are less likely to cave, and fewer holes require cleaning or re-drilling prior to loading of explosives. If more than two ft is lost at the bottom of a hole, it is considered too short for blast hole use. Short holes, which sometimes delay blasting schedules, amounted to approximately five percent of the holes drilled by churn drills as compared to two percent since rotary drills have been used. Also the smoother bore of the rotary drill holes facilitates loading of explosives with less danger of caving occurring during loading.
3. "Collar" casing is not required, whereas all churn drill holes required the use of steel surface casing during drilling. Approximately 25 percent of this casing, which averaged 11 ft long, could not be pulled before blasting. In the muck pile it was of some nuisance in shoveling, and it had to be finally removed from the pit.

The principal disadvantage connected with the use of the rotary drills has been that of making frequent moves from one area to another. More detailed planning is required than formerly to avoid delays, and considerable more bulldozer time is required to prepare ramps and roads for the moves. Fortunately, even some of the longest moves, which cover as much as a mile with a change in elevation of possibly four levels, can be made with the mast up. A large bulldozer is used for towing a drill on any major moves.

Ore control at Morenci is based upon blast hole samples and sampling is an important phase of the drilling operation. Originally, each pile of

Table 1

AVERAGE DRILLING DELAYS AND CONVERSION OF PENETRATION RATES TO FEET PER SHIFT

Let: R—rate of penetration (ft per hr)
d—average depth of holes (ft)
n—number of holes drilled per shift
A—average delay time per hole (hr)
B—average delay time per shift (exclusive of A) (hr)
E—average efficiency (ft per drill-shift)

Then: $n\ (d/R + A) + B = 8$ hr and $n\ d = E$

Whence: $E = \dfrac{(8 - B)\ d}{d/R + A}$

Type of Delay	*Minutes per Hole*
Adding drill rod	3
Retracting and removing rod	5
Changing bit (20 minutes/change)	1
Moving and setting up	8
Miscellaneous	4
Total delays per hole	21 or 0.35 hr = A
Travel time	30
Greasing	15
Miscellaneous	30
Total delays per shift	75 or 1.25 hr = B

Substituting average values for A and B and assuming an average depth (d) of 65 ft:

$$E = \frac{439}{65/R + 0.35}$$

Representative values of R and E:

R (*ft per hr*)	*E* (*ft per shift*)
30	174
40	222
50	266
60	306
70	343
80	378
90	409

cuttings remaining after the hole had been completed and the drill moved was quartered and split to obtain the sample. This method has the disadvantages that cuttings obtained below the mining level become part of the sample and doing the work properly is laborious. The present practice is to set a specially designed sample can in a predetermined position next to the drill hole. During drilling, a small portion of the cuttings emerging from the hole are deflected into the sample can. When shovel grade is reached the opening to the can is covered. The accuracy of this type of sample is believed to be somewhat less than that of the churn drill samples formerly recovered. However, variations between samples and check samples are accidental in character, and no systematic errors that result in consistent over or under valuation have been detected.

Advantages of 12-Inch Drill Holes

When the heavy churn drills were first put into service, some were equipped with tools for nine-in. drilling. At that time it was found that the rate of drilling nine-in. holes did not exceed that of 12-in. holes by more than 10 percent. The cost differential per foot of drill hole was less than 15 percent in favor of the smaller holes. In the case of rotary drills, although nine-in. holes have not actually been drilled, the evidence is that an increase in drilling rate of from five to 10 percent over present rates would be all that could be expected. The smaller rotary bits cost less but also have a shorter life than the 12¼-in. size, so it is probable that the cost per ft of nine-in. rotary drill hole would be on the order of 10 percent less than present 12-in. hole costs.

As has been previously discussed, in the prophyry areas of the Morenci pit, it was possible to increase the tons broken per ft of hole a great deal more than 15 percent through substitution of 12-in. holes for nine-in. holes. The tons broken per lb of powder remained approximately the same, and the factors of shoveling and track work were not affected. The overall economy of using 12-in. holes is therefore apparent, regardless of which of the two types of drills is being used.

In addition to the reduction in the feet of drill hole required to break the ground, there are a few additional features of large hole drilling with its resulting wide hole spacing that are desirable:

1. The fewer number of holes and the larger hole size facilitate loading of explosives.
2. Less detonating fuse is required.
3. Missed holes are more easily detected.
4. Within the loading zone it is easier to keep stacks of explosives separated a sufficient distance to reduce propagation hazards, and there is less general congestion.

Summary

Drilling and blasting experience in the Morenci pit has demonstrated that, in rock which naturally fragments well, 12-in. diam blast holes offer marked advantages over nine-in. holes. In order to more fully exploit the larger hole size it is necessary to increase sub-grade drilling beyond that which is conventionally used.

Large rotary drills have recently replaced churn drills for the drilling of 12-in. blast holes. Drilling rates have been over 2.6 times those of the churn drills. The indicated cost per foot of hole is two-thirds the corresponding cost for churn drill holes. In addition to the saving in drilling costs, a number of other benefits have been realized.

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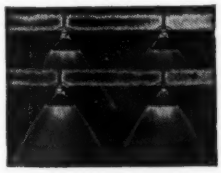

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Experiences in High Voltage Distribution Underground

In four years of experience with up to 90,000 ft of high voltage distribution cable underground, this large coal producer has had just 12 outages due to cable failure. Only one could have been caused by poor installation

By

JOHN W. LOONEY

Electrical Engineer, Pocahontas Fuel Co.

PRIOR to December 1954 Pocahontas Fuel Co. purchased power from the power company at voltages to be used and where needed. The power consumed was metered at each utility point. Meter readings were totaled and billed on a power consumption basis.

Under this system, all d-c conversion equipment was located above ground and d-c power was fed to the mining system through boreholes and drifts. From a voltage regulation standpoint, this was satisfactory with limited mechanization. As the mines became mechanized, it became apparent that portable converting equipment which could be kept close to the face equipment was needed. Because the power company would not take converting equipment underground, it became necessary for the coal company to purchase all power facilities and to obtain equipment to take conversion equipment underground.

Company Goes to 13.2-KV Underground Distribution

For voltage regulation and convenience, it was decided to go to 13.2-kv underground distribution. All overhead transmission was 13.2 kv. The load on any one borehole would be very hard to anticipate; therefore, it would be unsatisfactory to attempt to install step down transformers at each entrance. Pocahontas Fuel has cable entrances with from 300 kw to 3000 kw connected loads.

In all cases, the plants are served by transformers connected 13.2 kv grounded neutral. Three conductor No. 2 cable with the following specifications was chosen as a standard for underground distribution: 3 conductor, semi-con tape, 19/64 in. super coronal insulation, colored semi-con tape, shielded, twisted with No. 6 AWG strand coated ground wire, 8/64 in. neoprene or geoprene jacket. A 2/0, 3 conductor armored cable was chosen as a standard for boreholes.

Each borehole or cable entrance is protected by a 600-amp oil circuit breaker using inverse time overcurrent relays, as well as instantaneous and inverse time overcurrent relays for current differential protection. The oil circuit breaker may have its associated protective relays mounted in a cabinet on one side of the breaker, but this is not always the case. For instance, if the breaker is installed near a building, the relays may be mounted inside the building.

1000-Ft Cable Sections Used

It was decided to terminate each 1000 ft of cable with disconnecting potheads, for two main reasons. First, this will allow the cable to be moved without cutting and resplicing and second, a damaged cable can be replaced much faster than it could be spliced. Replacement of the cable which has been potheaded on each end, is so simple that in one case a cable was replaced even without stopping the face equipment.

Potheads are mounted on a standard stand which is built so that the potheads are mounted on a 45° angle. This angle allows the cable to be placed in a long radius bend and still keep a low stand.

At the bottom of all boreholes and at all loads and branches, a gang operated oil filled cutout has been installed. This allows sectionalizing in case of trouble. At the bottom of all boreholes, there has been installed a remote control switch and pilot lights for the oil circuit breaker at the top of the borehole. In the case of an entrance at a drift, the switch and pilot lights are mounted on a control cubicle on the oil circuit breaker. A limit switch trips the breaker in case an attempt is made to open the oil switch. The oil switch is rated to open the normal load, but the limit switch operation of the oil circuit breaker is merely a precautionary measure.

One Man Can Make Three Pothead Installations in Four Days

As experience has been gained in installing potheads, the procedure has grown. In the beginning, potheads and associated equipment were made up at the plant at which they were to be used. This has been changed and all potheads are installed and associated equipment built in Pocahontas. This has been done for several reasons, but the major reason was so that the work could be given closer supervision. One thing that management has feared with regard to pouring a pothead at location is contamination. The room in which the work is carried out in Pocahontas is away from dust and other material that could contaminate the cable or compound.

In the beginning, four men were used to install the potheads. At the present time, one man works at the central location in Pocahontas and can make approximately three pothead installations in four days.

The reduction in manpower has been due primarily to the selection and adaptation of tools. Following are a few examples of the labor saving devices now in use. The first and greatest labor saving device has been an electric double boiler for heating the compound. Originally, compound

was heated by a gasoline burner which kept one man busy as well as being inaccurate as to temperature. With the present electric boiler, a thermostat gives a controlled temperature with no attendance. The double boiler was built at the plant and consists of a large container with two 1000-watt tubular heaters into which a five-gal pail of compound can be set. The company was unable to find a suitable double boiler on the market.

A second labor saving device was the use of a vise and form clamp to hold the cable while it is being taped. This takes the place of an assistant. The only part of cable that may be damaged is a portion which will be cut off in order to install a section of the disconnect. Third, the company has found that the most important step in either splicing or installing a pothead is in removing the semiconducting tape from the cable. In making the first stress cones, this material was removed with files—a long and laborious process. Since that time a sanding disc which is driven by a ¼-in. electric drill has been substituted.

Although none of the above tools were originally developed to be used for these purposes, their adaptations have reduced the man power and time required for installation of potheads. Management is continually looking for other tools that will speed the installation of potheads.

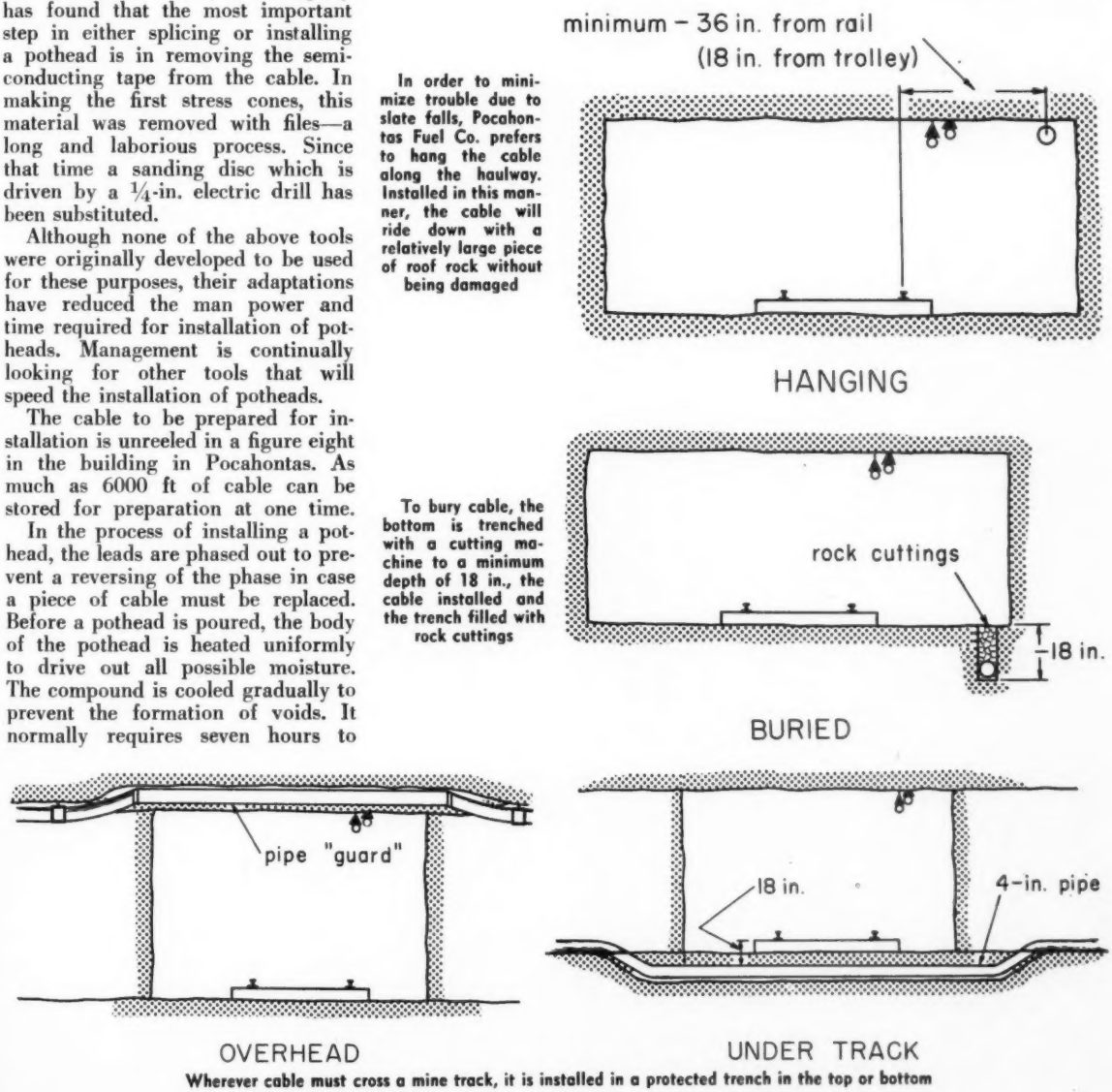
The cable to be prepared for installation is unreeled in a figure eight in the building in Pocahontas. As much as 6000 ft of cable can be stored for preparation at one time.

In the process of installing a pothead, the leads are phased out to prevent a reversing of the phase in case a piece of cable must be replaced. Before a pothead is poured, the body of the pothead is heated uniformly to drive out all possible moisture. The compound is cooled gradually to prevent the formation of voids. It normally requires seven hours to pour and properly cool the compound in a pothead. The man who is watching this compound is at the same time preparing a second cable termination to be finished the next day.

The first borehole pothead that the company installed turned out to be an endurance test. Two weeks were spent watching the sky to find a rainless day. When the day arrived, it turned into a 15 hour work day by the time the installation was cool enough to leave.

Since that time, for a borehole cable or any cable that must be in place before the pothead can be installed, a pothead will be installed in a short piece of cable in Pocahontas and spliced to the cable at location. This allows the pothead to be prepared ahead of time and eliminates the need of moving the compound heating equipment to the plant. Under these arrangements, the short piece of cable with a pothead mounted can be spliced on the cable in a regular shift by two men. It is felt that all work which can be done in Pocahontas under controlled conditions and ahead of actual installation date will prevent much rush and worry that normally go with the installation of new equipment. The company attempts to have from four to six cables available in Pocahontas at all times.

To move the cables to a plant, they are placed on a truck in a figure eight and are transferred to a mine car in the same manner. In moving



In order to minimize trouble due to slate falls, Pocahontas Fuel Co. prefers to hang the cable along the haulway. Installed in this manner, the cable will ride down with a relatively large piece of roof rock without being damaged

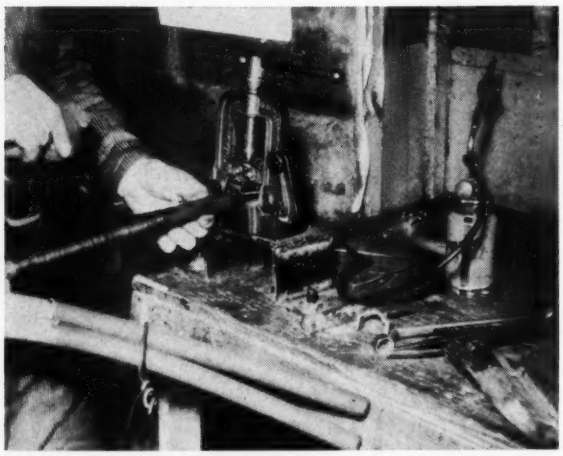
To bury cable, the bottom is trenched with a cutting machine to a minimum depth of 18 in., the cable installed and the trench filled with rock cuttings

Wherever cable must cross a mine track, it is installed in a protected trench in the top or bottom

the cable, care must be taken to prevent damage to pothead insulators and the cable itself.

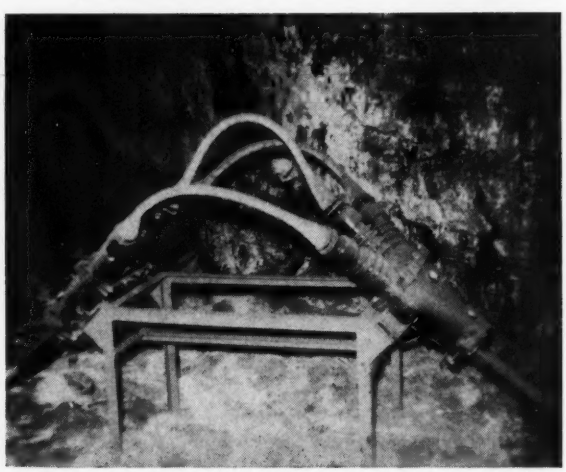
Hanging Cable Minimizes Trouble Due to Slate Falls

Of the 90,000 ft of cable that Pocahontas Fuel has had in use from one to four years, there have been 12 outages due to cable failures. Eight were due to slate falls. These have ranged from a single piece of slate no larger than a double hand, to falls that required all day to clear up. Two cases could not be traced to external causes; therefore, they were attributed to either defective or, more likely, mishandled cable. One failure was caused by an air receiver blowing up and cutting the cable. The last failure was in a pothead and could have been due to poor installation.



The company is continually looking for tools that will speed the installation of potheads. One labor saving device employed is a vise and form clamp to hold the cable while it is being taped. This takes the place of an assistant

The double boiler for heating compound consists of a large container with two 1000 - watt tubular heaters



Potheads are made on a standard stand which is built so that the potheads are mounted on a 45° angle. This angle allows the cable to be placed in a long radius bend and still keep a low stand

In order to minimize trouble due to slate falls, the company prefers to hang the cable along the haulway. The haulway is better maintained in so far as slate is concerned and installation and replacement of cable along the haulway can be accomplished much faster than in a back entry. It has been found that cable which is hung will ride down with a relatively large piece of rock without being damaged. At least four of the failures described could have been prevented if the cable had been hung along the haulway. In only one case has a cable been damaged on a haulway due to slate falls.

Although the haulway has advantages not offered in a back entry, most of the company's cable has been installed in back entries. This cable has been hung as well as laid on the floor. There has been one case of trouble with cable hung in a back entry but this is believed to be due to mishandling the cable. When the cable passes through a section of bad top, a double line of timbers is normally set to protect the cable. As can be seen from the above, Pocahontas Fuel prefers to hang the cable.

At any point at which the cable must cross the track, it is installed in a protected trench within the top or bottom.

So far, the practice has been to locate a fault through visual inspections. Because most faults have been caused by rock falls, the trouble has been easily located. By installing the cable in 1000-ft sections, a faulty section can be quickly located and replaced if not repaired.

With the type cable being used, the major difference between 5000 volt and 15,000-volt cable, so far as the company is concerned, is the thickness of insulation on the individual conductors. So far as the company is concerned with field work, this is reflected in the thickness of insulation that must be maintained, under the shielding braid and the lengths of stress cones. Management has changed to a pothead with a larger body in order to maintain the spacing and insulation thickness necessary with the higher voltage. Originally, a size four body was used, but now a size five is employed.

Because the greater portion of cable failures have been due to out-

side circumstances, the company believes that it would have had at least ten failures regardless of the voltage used.

Although Pocahontas Fuel has underground circuits as long as 14,000 ft with 500-kw units at the most distant points, it has had no trouble with voltage regulation. In one case, cable was extended at a rate of 6000 ft per year. It is believed that this would not be practicable with a lower distribution voltage.

There have been no failures in equipment that could be traced to high voltages, such as arc overs. Two current transformers have failed, but these were traced to open secondaries and arc backs on the rectifier. One compressor transformer has failed, but this could not be traced to the high voltage.

Patience and Carefulness Are Essential

In summary, Pocohontas Fuel has had excellent results in voltage regulation, no equipment failure traceable to the high voltage, and a minimum of cable failures that could have been caused by the higher voltage.

As anyone who uses high voltage cable will learn, two things are necessary to the success of the use of high voltage. First is cleanliness and patience in preparation of the cable. Second is carefulness in handling the cable. The watch words for Pocahontas Fuel in preparation and installation of cable have been patience and carefulness.

BITUMINOUS COAL—

The Next Five Years

(*Continued from page 31*)

to prohibit the reckless waste of natural gas in industrial markets—a practice which usually results in higher gas prices for the household consumer, and eventually less supplies for domestic use.

New markets are opening up for coal. A good example is the aluminum industry in the Ohio Valley, where the job of generating power for aluminum production requires about seven tons of coal for every ton of aluminum produced. An aggressive coal industry can find and develop other markets—not all of them large, but impressive when all are lumped together. For instance, the Interior Department thinks it is making progress toward developing a process for producing fresh water from the sea or brackish water. Many parts of the country, including areas right here on the East Coast, are running out of usable water supplies. If water desalting plants are built to overcome this shortage—and some are now in the demonstration stage—they probably will use large amounts of fuel—and in coal areas, it is up to us to see that the fuel used is coal. As now projected, one of these plants would use 770 tons of coal for every 10,000,000 to 15,000,000 gallons of water. Even if this process is put into use this would not be much of a market by 1963, but it is one which will bear watching in the future.

With the rapid expansion of our population, there will be other opportunities to develop new markets for coal. The bumper crop of babies of the 1940's will be having families of their own in a few years. The growth of our population is accelerating. Every one of these new citizens is a consumer of coal, directly or indirectly.

Our expanding economy will need tremendous amounts of energy, and there is room in this economy for all fuels, including bituminous coal. There are certain uses for which their fuels are best suited or preferred, just as coal is best suited for many purposes. The coal industry is going to fight to expand its markets. Most experts agree that to meet the needs of the future, America will need all its fuels—especially the abundant reserves of bituminous coal.

				PERCENT OF CHANGE		
	1946	1947	1958	1957/1946	1958/1946	1958/1957
Bituminous Coal	500,386	413,668	364,899	-17.3	-27.1	-11.8
Anthracite	52,255	20,345	19,532	-61.0	-62.6	-4.0
Petroleum Products	185,926	288,527	295,498	55.2	58.9	2.4
Natural Gas	104,166	340,133	351,308	226.5	237.3	3.3
Hydro Power	55,194	63,668	64,856	15.4	17.5	1.9
U. S. Total	897,927	1,126,341	1,096,093	25.4	22.1	-2.7
PERCENT OF TOTAL ENERGY						
Bituminous Coal	55.7	36.7	33.3	—	—	—
Anthracite	5.8	1.8	1.8	—	—	—
Petroleum Products	20.7	25.6	26.9	—	—	—
Natural Gas	11.6	30.2	32.1	—	—	—
Hydro Power	6.2	5.7	5.9	—	—	—
U. S. Total	100.0	100.0	100.0	—	—	—

Table I Contribution of competing fuels and water power to the total U. S. Energy Market, 1946 vs. 1958

(Thousands of Bituminous Coal Equivalent Tons)

	1946			1958		
	Rank	Net Tons Consumed (000)	Percent Total Consumed	Rank	Net Tons Consumed (000)	Percent Total Consumed
Electric Power	5	68,743	12.7	1	152,928	36.9
Railroads	2	110.166	20.3	7	3,725	0.9
Coking Coal	4	83,288	15.4	3	76,597	18.4
Industrial Steam	1	139,505	25.8	2	97,945	23.6
TOTAL INDUSTRIAL		401,702	74.2		331,195	79.8
Retail Deliveries	3	98,684	18.2	5	33,704	8.1
U. S. CONSUMPTION		500,386	92.4		364,899	87.9
Exports—Canada	6	21,880	4.0	6	12,233	2.9
Exports—Overseas	7	19,329	3.6	4	38,047	9.2
TOTAL CONSUMPTION		541,595	100.0		415,179	100.0

Table II Bituminous coal consumption, by markets 1946 vs. 1958

	Electric Utilities	Coking Coal	Industrial Steam	Total Industrial	Retail Deliveries	Total U. S. Consumption	Canadian Exports	Overseas Exports	Total Demand
1954	115	85	111	311	52	363	16	15	394
1955	141	107	122	370	53	423	17	34	474
1956	155	106	123	384	49	433	21	48	502
1957	157	108	113	378	36	414	18	58	490
1958	153	77	101	331	34	365	12	38	415
1959	165	103	100	368	32	400	14	25	439
1960	172	107	108	387	33	420	15	30	465
1961	187	108	110	405	32	437	14	30	481
1962	195	109	112	416	30	446	13	30	489
1963	205	110	114	429	29	458	12	30	500

Table III Projected markets for bituminous coal, 1959–1963
By Classes of Users
(Millions of Tons)

Aside from the most important consideration of any accident, human loss and suffering, just what does a mine accident cost in dollars and cents?

THE COST OF MINE ACCIDENTS

HERBERT R. WESTLUND
Chief Safety Engineer
Argonaut Insurance Co.

WHEN the author was first requested to discuss the "Direct and Indirect Costs of Mine Accidents," his first thought was that there must be a difference between the accidents occurring in the mining industry and other types of operations. After trying to separate or distinguish the difference he came to the conclusion that the only difference there could possibly be is in the physical aspect of the accident, and that the ultimate effect upon cost is exactly the same in all industries—an added cost item to production.

Before getting into the more technical aspects of Direct and Indirect Costs two items should be clarified. First, the following discussion will cover only the cost of accidents involving combined personal injury and property damage as related to workman's compensation coverage and will not go into the costs involved in liability, property damage, fire and other phases of insurance coverages. And secondly, no attempt will be made to evaluate the human loss and suffering, a most important factor in any accident analysis.

Common Terms Defined

In order to have a mutual understanding of the subject there are a few items that should be defined. First of all, what is an accident or injury, as these terms are often interchanged?

Accident—The dictionary defines an accident as, "an event that takes place without one's foresight or expectations." In other words, an unintended occurrence arising out of employment that results in either personal injury, property damage, or both. There is room for controversy here but let's accept this definition for the time being.

Injury—Webster says, "that which occasions harm morally or physically—detriment—loss—damage." For our purpose, let's assume injury means damage to the human body. Of course, we can have an accident without personal injury, but its almost impossible to have a personal injury without an accident.

Direct Costs—Now let's talk about something we know all about—or do we? The common definition or explanation of direct costs has been the cost of indemnity or compensation paid plus the medical expenses incurred. Simonds and Grimaldi in their recent book, "Safety Management," have classified this cost as the insurance cost or insured cost. The insurance industry has used this phraseology for some time and it has recently been recognized by the National Safety Council. Be that as it may, the author's opinion is that both mean exactly the same thing.

In computing the direct or insured cost of accidents it has been common practice to consider only the total indemnity and medical costs and to ignore the total net cost of workman's compensation insurance for the operation. This procedure, without question, will lead to an erroneous conclusion when attempting to evaluate the overall results.

For example, assume a mining operation develops an annual compensation premium of $100,000 for the year. The policy is written on a retrospective plan, dividend plan, or other plans that will return a percentage of the gross premium based on a favorable loss ratio or accident performance. The company's record was good in that it received a return premium of, let us say, $15,000. This it got after expiration of its policy and a reasonable time for settlement of serious claims.

Therefore, the net direct or insured cost is $85,000. The insurance company may have paid out only say $55,000 on compensation and medical costs, but the mining company is out $85,000 for the privilege of having accidents—this is the direct net cost it has paid. The $30,000 retained by the insurance company is their fee for handling claims, paying attorneys, taking the insurance risk and the chance of making a profit. In this example the profit would be small, if any. The next year with an adverse experience this could be reversed. Assuming compensation and medical costs exceed the $100,000 of premium paid, the net direct costs would still be only $100,000 and the insurance

carrier would assume the difference.

The process of arriving at direct or insured accident costs is not difficult and should produce a fairly accurate result. The determination of indirect or uninsured cost will be much more challenging and will be covered next.

Indirect Costs—This description has long been applied to those indefinite costs such as lost production, property damage, and other items that will be covered shortly. However, first let's examine the term "indirect costs" and consider this also as uninsured costs or those costs not normally covered by insurance. This term has also been advanced by Simonds and Grimaldi in their book and, the author believes, accepted by the National Safety Council. Let us examine the items normally included under the indirect or uninsured costs.

1. Net cost of replacing or repairing equipment or other property damaged as a result of the accident
2. Wages paid to workers other than injured party
3. Training replacements
4. Wages paid supervision for time necessary to handle accident and establish order in production
5. Uninsured medical costs
6. Wages paid injured worker for lost time other than workman's compensation payments
7. Production loss

It would be impossible here to cover all of the factors involved in the seven items just discussed, let alone several additional items that must be considered such as cost of renting equipment if necessary, loss of profit, possible cancelled orders, cost of hiring new employees, and so on. From the foregoing, however, the reader will agree it is extremely difficult to determine an exact indirect, or hidden cost, as it is also commonly referred to.

Minor Accident Used As Example

As an example of the difficulty in the mining industry in determining the indirect cost of a simple accident that could occur under different operating conditions let's take a miner working in a production stope, producing approximately 20 tons of ore per shift. The steel breaks in his stoper and his machine drops hitting him on the ankle. He is taken to the mine dispensary, if available, or checked by the foreman to determine if the injury is serious enough to be examined by a doctor, which it is. As he can't drive it is necessary for someone to take him. The doctor checks him out, takes X-rays and finds nothing broken, consequently advises the injured man that he can return to work the next day. What has this accident cost you in indirect costs?

If this miner should be injured in an accident, the indirect costs not covered by insurance might amount to several times the direct costs. Frequently, however, mining companies do not take indirect costs into account, for generally they have little factual basis for determining how much money is involved. A proven ratio of indirect costs to direct costs is a potent factor which demonstrates the value of a good accident prevention program.

1. Cost of equipment—one starter steel. There was no other damage to the equipment $ 2.00
2. Wages paid to other workers for lost time—not bad—his chuck tender only took an hour to help him to the surface and return. 2.50
3. Training Replacements—We won't count this as he wasn't replaced for the balance of the shift. None available. 0.00
4. Wages paid supervision—Again, luckily it took the shifter only 1½ hours to check out the injured employee and make another trip to the stope to reassign the chuck tender. However, the surface foreman took the injured man to the doctor in his car which involved about three hours lost time. A reasonable charge was made here for the shifter and surface foreman. 10.50
5. Uninsured medical costs—As only a few minutes were spent in the dispensary or first aid department, only a minor charge can be made. 1.00
6. Wages paid—not covered by insurance—seven hours at $2.50 per hour. The accident occurred one hour after starting shift and injured man was paid for the balance of the shift. 17.50
7. Production Costs—Will not add this cost in at the moment but will cover it shortly.

Total indirect cost, hidden, uninsured, or call it what you want, would be approximately $33.50. Therefore, it isn't too difficult to arrive at a fairly accurate and conservative charge for these items—but wait, are these the total indirect costs?

The author mentioned at the start that this miner was in a production stope producing an average of 20 tons of ore per shift. The employer was unfortunate in having no reserve ore supply available either in the bins or shoots and a four-hour shutdown was necessitated in the mill the next day as a result of this accident.

At a net profit of $2.00 per ton another $40.00 has to be added to the already itemized indirect cost of $33.50, making a total of $73.50. In addition, charges should be made for the cost of starting and stopping mill operations, overtime to regain tonnage and other costs that would not be incurred in normal operations. However, as these are too indefinite no charge will be assessed at this time.

Now take the same miner and put him in an exploration raise or drift. The production loss could not be included as it would not immediately affect production, although it might at a later date. If he had been work-

ing for that large company paying $85,000 in premium, unquestionably the production loss would be minute and almost impossible to determine. In a very limited space one cannot cover the many and varied circumstances affecting each one of the few items listed that comprise the indirect or hidden costs of accidents.

Ratio of 4 to 1 Frequently Used

For this reason it has been common practice to apply a ratio of indirect costs to direct costs, the most common being 4 to 1. The reader has probably heard those figures from an insurance carrier, safety engineer, National Safety Council, or someone else. The author has quoted them many times when trying to convince employers of the economy of accident prevention. Management has resisted this comparison quite frequently, but seldom do they make a determined effort to secure relatively accurate indirect costs.

In the example just discussed there is no problem in determining the direct or insured costs. The fee for the doctor's services was $7.00 plus $10.00 for X-rays, or $17.00. The ratio in this case would then be, without production loss included, almost exactly 2 to 1; including production loss it would be over 4 to 1, certainly a substantial difference.

A study was made in recent years by Simonds under the auspices of the National Safety Council and the American Society of Safety Engineers to determine a more accurate method of arriving at the indirect cost of accidents and the elimination of the controversial issue of 4 to 1. Briefly, it was found that by pilot study averages can be reasonably ascertained for various types of accidents such as lost time or indemnity, medical only or doctor cases, first aid cases, and so on for any operation. In this program shock or catastrophe losses are evaluated individually to give a truer picture.

You may be wondering why the author believes it is so important to know more accurately the indirect costs. Probably it could be more impressive to use 4 to 1. Take the example of the company paying a net direct cost of $85,000 at 4 to 1, or a total indirect cost of $340,000. At a net profit of $2.00 per ton of ore handled this would amount to the profit on 170,000 tons or units processed or several days' operation even for a large organization.

But management today wants facts —not theoretical ratios. If you approached the manager of this company and cited the figures just related, he would have serious doubt as to your ability—might even suggest having your head examined. *However*, if you could confidently state that you could *prove* the indirect costs to within a reasonable difference, with minimum cost and effort on his part, you would get a more attentive ear for your accident prevention program.

COAL TRANSPORTATION

(*Continued from page 44*)

blocks also looks very promising (see figure 6). Splits off the block being pillared are 13 ft wide. The left split is longer than the right. Eight-ft thick fenders are left on the gob side of each split and are retreated as soon as the split is finished. Small stumps remain.

During the first six shifts of operation the mine produced 284 tons per shift at 44 tons per man. A ten-ton car was observed filled in 2 minutes and 15 seconds. Later, on one particular shift, the best to date, the performance was 546 tons at 91 tons per man. This appears promising.

Difficulties in Developing Haulage Equipment Not Insurmountable

In conclusion, it is believed that there are great possibilities for the continuous-type haulage units available, especially in high coal, provided improvements are made and prices are not excessive.

Bethlehem's experiments with the so called continuous-face haulage systems now available have convinced it that no one has come up with a solution to this pressing need in the industry. The company has high-capacity continuous mining machines, but so long as they can produce only during the same proportion of available time as was possible with conventional loading machines, the name "continuous mining machine" cannot be justified. It is believed that the greatest potential for significant increase in face production per man lies in the development of face-haulage equipment to match the continuous-mining machines.

The company's span of experimentation from 1951 to 1959 was slow because the type of haulage equipment necessary has not been available. Development of this type of equipment has not received its due share of attention. Bethlehem is convinced that the difficulties in developing continuous face-haulage equipment, for the very short lengths of spans involved, are not insurmountable and that the urgent demand will bring a solution. For the welfare of the sorely pressed coal industry, all segments of the industry should unite their talents and resources in the development of equipment to eliminate this most restrictive bottle-neck in face production.

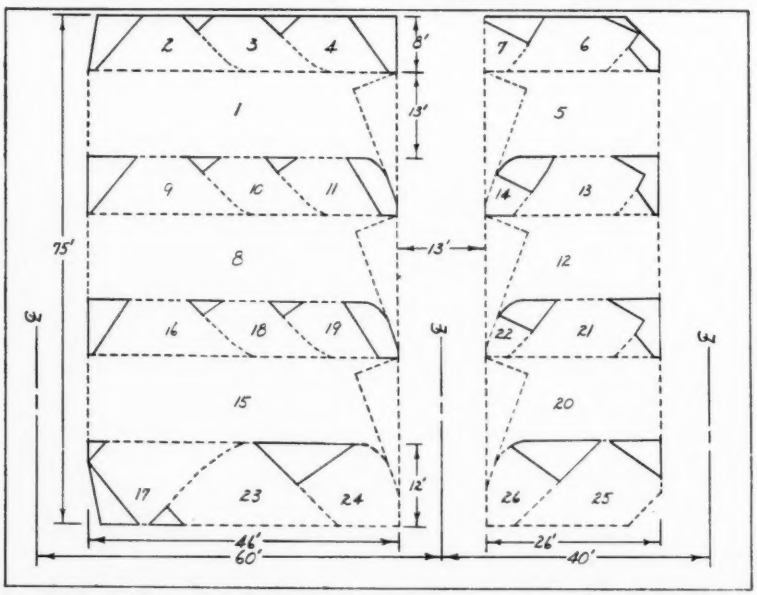
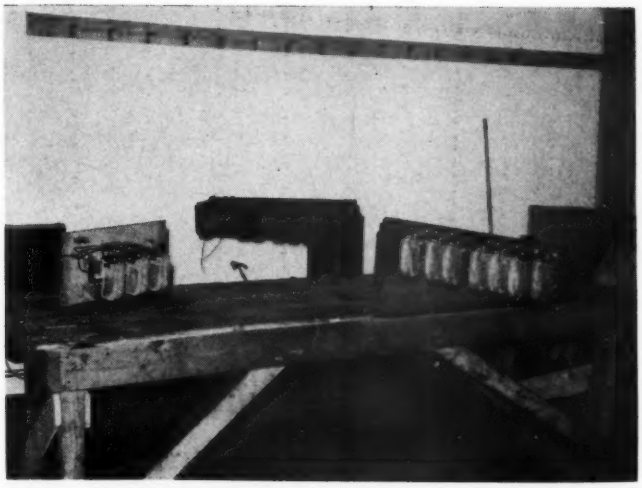


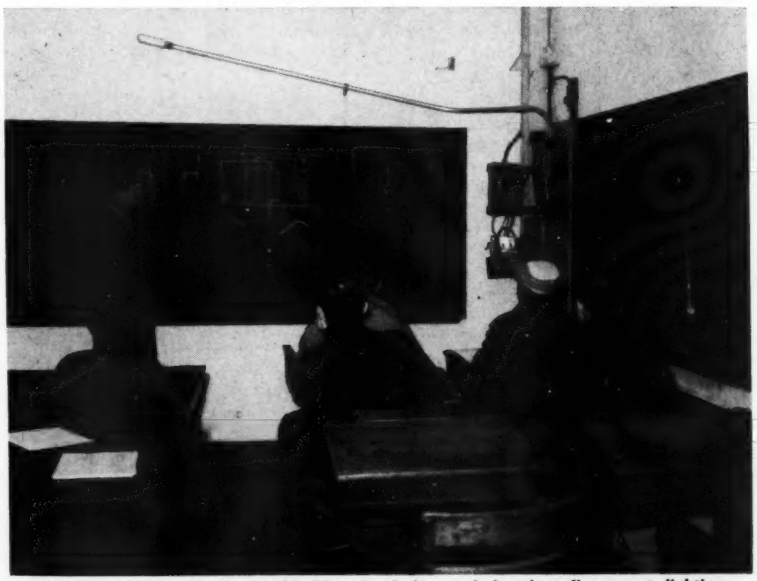
Fig. 6. Pillaring with bridge and extensible belt in high coal. Splits off the block being pillared are 13 ft wide. The left split is longer than the right. Eight-ft fenders are left on the gob side of each split and are retreated as soon as the split is finished

Training Maintenance Personnel



Loading machine control panels were used in classroom exercises. At intervals during the training program, true-false and multiple choice tests were given to help determine the progress of the class

Working three shifts per day, five days a week for many years, Warwick Mines found little time for preventive maintenance, making trouble-shooting at the face extremely important. Locating and repairing electrical breakdowns on continuous mining equipment posed a major problem and the company inaugurated a formal training program designed to increase the proficiency of mine mechanics in coping with electrical troubles



Classroom was equipped with blackboards, desks, work benches, fluorescent lighting, warm air heating and a-c and d-c power. There was also sufficient floor area to permit a mining machine to be brought into the classroom for practical demonstrations

By

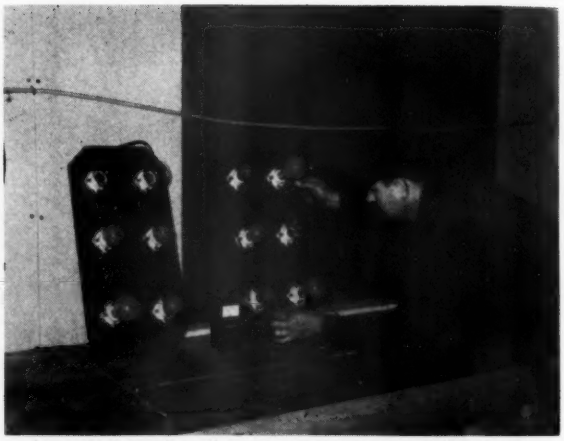
ALBERT R. HOOD

Superintendent, Warwick Mine
Duquesne Light Co.

TRAINING of maintenance personnel to trouble-shoot electrical breakdowns at the working face was a major reason for establishing a formal training program for mechanics at Duquesne Light Company's Warwick Mines. (*Note: All men engaged in making mechanical or electrical repairs are classified as mechanics at Warwick Mines*).

As the company's mines became more highly mechanized with the

Checking armature for short circuit. Company mechanics are taught that, if a short circuit is discovered, the motor should be removed from service and sent to the shop for repairs. However, if a ground is detected, it should be removed and the motor continued in service



Lamp bank used to demonstrate series and parallel circuits during study of Ohm's Law

addition of continuous mining machines, it became apparent that the traditional mine mechanic was just that, a mechanic. He could make mechanical repairs but could seldom locate and repair electrical failures within a reasonable time.

Warwick Mines have worked three shifts per day, five days a week for many years. This leaves very little time for preventive maintenance and makes trouble-shooting at the working face extremely important. Accepting all of these things as facts, management decided that a definite course of instruction was necessary, this to be provided as a part of the regular work shift of each mechanic. A classroom was provided near the company's outside shop and was equipped with blackboards, desks, work benches, fluorescent lighting, warm air heating, a-c and d-c power, and plenty of floor area so that a mining machine could be brought into the classroom for practical demonstrations.

Course Prepared by Master Mechanic

Subject matter for the course was prepared by the master mechanic who had served eight years as an instructor in mining electrical vocational classes under the sponsorship of the Mineral Industries Service of Pennsylvania State University. He had many years of practical experience in maintaining mining equipment, was well aware of the problems the company faced, and knew the abilities of the men to be trained.

The instructor chosen for the training program was a young man who had worked as an underground mechanic for 12 years, attended all of the vocational classes conducted by the master mechanic, and possessed definite leadership qualities.

All shop and underground mechanics received the training. They were divided into three groups. Group one worked steady day shift for eight weeks and each member of the group attended classes of from three to four hours duration twice each week for a minimum of 48 hours of instruction. Groups two and three followed in turn. The master mechanic assumed the role of instructor as the classes were started and took over as each new subject was introduced. Remaining classes were conducted by the regular instructor. The course was opened with a short study of basic electricity, including Ohm's Law; characteristics of series and parallel circuits, and the proper use of meters and instruments. A limited time was spent in blackboard or written drills. Instead, each point, as presented, was backed up by a practical demonstration with test equipment.

Basic Principles Studied

Basic principles of electric motor operation, and the function of relays, contactors, coils, and mercury switches were thoroughly studied. Each of these machine components was broken down so that its operation could be studied and its place in the operation of a machine would be more easily understood. A study of electrical symbols and reading of electrical diagrams was an important part of the training. Here the men were taught to trace control and motor circuits and to refer to electrical components by their diagram designation such as: contactor—lm, coil —lla, etc. This has proven extremely helpful in discussing machine troubles and ordering the necessary parts for repair work.

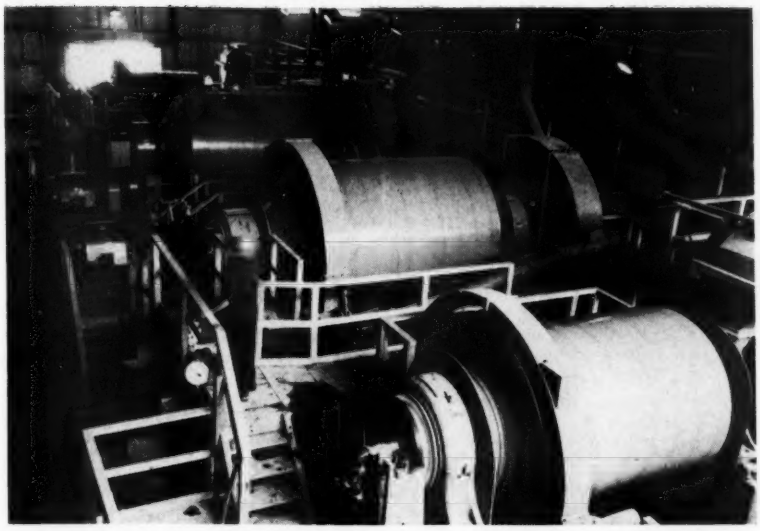
A Joy 14BU control panel and a Joy 4 JCM continuous miner control panel were then studied. Each mechanic wired both of these control panels, connected them to an electric motor, and tested each circuit to be certain that his work had been done correctly. This testing was always done in the following sequence: on-off switch, reset, right cat, left cat, pump, and conveyor. This sequence was taught to give the mechanics a routine to follow in looking for trouble and checking the operation of the machine after the trouble had been cleared.

Emphasis Placed on Testing

Use of a test light was given special attention. Every mechanic was taught to test for grounds between the motor circuit and the control circuit, for grounds between the control circuit and the frame of the machine, and for open circuits. Emphasis was also placed on using a test light for testing electric motors to determine if a short circuit or grounded motor existed. This was considered important because the company's mechanics are taught that if a short circuit is discovered, the motor should be removed from service and sent to the shop for repairs. However, if a ground is detected, the ground should be removed and the motor continued in service.

At this point in the training program, a Joy 14 BU loading machine

(*Continued on page 66*)



Uranium mills in the Canadian Bancroft area are using partial autogenous grinding circuits which are novel to the uranium industry. Shown is the grinding section at Faraday Uranium Mines Ltd. in Ontario. Two partial-autogenous, 9 by 11-ft pebble mills in center receive feed from two six by eight-ft rod mills

ADVANCES in Uranium Ore Processing

Extensive knowledge from research and operating experiences has been gained in the field of uranium extractive metallurgy. The techniques which have been developed are worthy of prudent consideration for application in recovery of other metals

By

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Metallurgical Engineer
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and

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THERE are now 66 uranium mills or plants in the free world having an aggregate ore processing capacity of between 124,000 and 125,000 short tons per day which are chemically producing a uranium concentrate. Besides doing specific research on uranium ore processing, these uranium mills are acquiring a wealth of new operating experiences as well as developing additional information on practices common to other phases of the milling industry. All of these are worthy of examination and prudent consideration by professional metallurgists. The extractive metallurgical developments and processes that have resulted from the vast amount of private and government research on uranium recovery should be reviewed for recovering other metals. When doing this, analogies should be made with the characteristics of the different types of uranium ores and the techniques used for processing those different types.

This presentation will call attention to some of the new developments in the uranium milling industry and certain variations that have been noted in the processes that make up a uranium mill flowsheet. It would be difficult and time consuming to try to mention all of them and many still would be overlooked. It must be emphasized that the significant developments which are noted here are selected to illustrate briefly the advancing technology.

Grinding

Uranium mills in the Canadian Bancroft area are using partial autogenous grinding circuits which are novel to the uranium industry. Minus ½ to ⅜-in. feed is rod milled in an open circuit with the rod mill discharge going to a classifier in closed circuit with a pebble mill. This secondary grinding circuit produces a 50 to 60 percent minus 200 mesh product. The pebbles used are a minus three in. plus 1½-in. run-of-ore product screened from the primary crusher discharge. Pebble consumption is from three to five percent of the crusher feed.

There are several advantages to using pebble mills for the secondary grinding circuit. Besides saving from two to three lb per ton of grinding steel, this decrease of fine iron in the pulp has another advantage for acid leaching uranium ore, because metallic iron consumes both oxidant and acid and the resulting ferric iron decreases the efficiency of uranium recovery in ion exchange operations, or

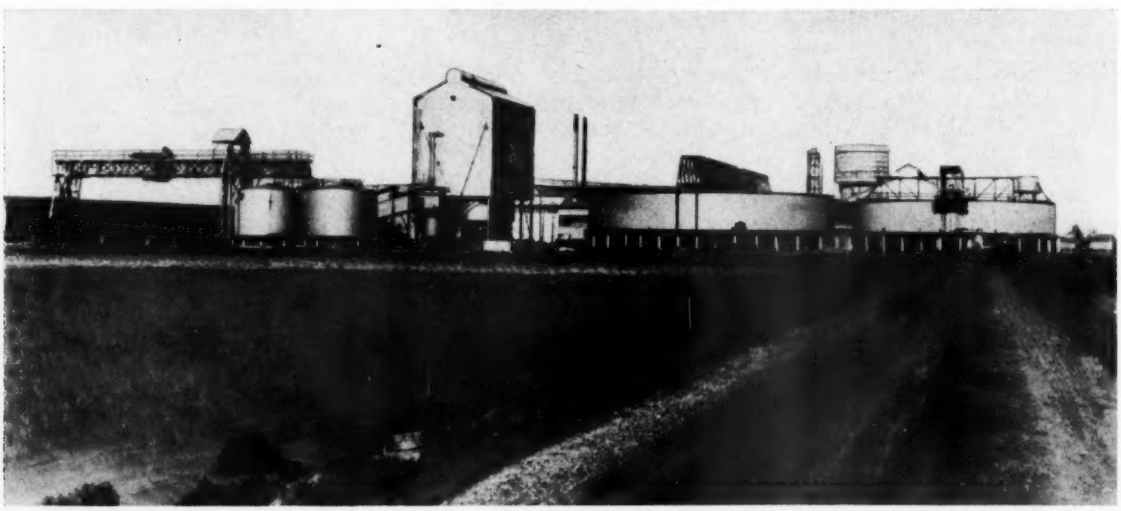
solvent extraction circuits using the alkyl phosphates, by competing for the active capacity of the extractant.

Leaching

During the past several years, many interesting, and in some cases, unique developments have occurred in leaching uranium ores. Several illustrations follow:

1. Under the usual conditions for acid leaching uranium ores, the liquors resulting from leaching the Australian Mary Kathleen ore contained large amounts of phosphate and silica which seriously interfered with ion exchange recovery of the uranium and generally fouled the resin. The South Australian Department of Mines discovered that by controlling the pH of the leaching at 1.8, and keeping the solution temperature under 40°C, the uranium could be selectively leached with only a small amount of silica and phosphate going into solution. This also reduced the acid consumption from 300 to 100 lb per ton. The Mary Kathleen mill is controlling its leaching to these conditions.
2. The Australian Port Pirie uranium plant leaches a davidite concentrate, an iron-titanium-uranium complex. This is a refractory mineral. The concentrate must be leached at boiling temperatures with strong sulfuric acid concentrations which dissolve the mineral and put the iron and titanium in solution along with the uranium. Subsequent pH adjustment of the pulp with lime after leaching and dilution in the counter current decantation (CCD) circuit resulted in a slow pre cipitation of the titanium throughout the remaining plant circuit, including the ion exchange resin beds. It was found that leaching at as high a percent solids as possible (60 to 65 percent) then dropping the hot leach charge into about four times its volume of cool mill liquor, followed by liming the resulting mix to give a pH of around one, quickly caused all the titanium to hydrolyze and precipitate from solution. The precipitated titanium is removed with the other undissolved solids in the CCD liquid-solid separation following the leach.
3. Some uranium ores, particularly those containing sulfides, are susceptible to natural leaching. As a matter of caution for stockpiling uranium ores, it has been found that from 60 to 80 percent of the uranium can be removed from certain ores in a relatively short time by weathering and natural percolation and leaching with water. The Urgeirica operation in Portugal has taken advantage of such natural leaching by bedding large piles of low grade ores on prepared pads and collecting the drainage from rain or spraying. The collected liquors are neutralized and the resulting sludges are taken to the Urgeirica mill for further processing. The ores used for natural leaching are those that are below the economic grade for Urgeirica mill feed but which must be removed in connection with the mine development and stoping.
   It has been found that the best results are obtained on a minus ½ or ¼-in. screened material. The addition of pyrite and small quantities of ferrous sulfate to the heap is beneficial to the natural leaching and, in some cases, essential.
4. Some of the South African uranium recovery plants receive their feed from several different sources. Occasionally the ore from one source exhibits a high degree of refractoriness to the optimum conditions desired in the leaching circuit. It has been found advantageous to separately leach such ores under more rigorous conditions of temperature and acid concentration, then add this leach pulp to the regular leaching circuit where the high residual acidity is utilized for the normal leach. At times this procedure appears to improve the regular leaching. The dual leaching circuit obtains over-all high uranium recoveries more economically than attempting to control the leaching conditions for the most refractory ore in a blend. The Vitro Uranium Company's Salt Lake City mill also has used such a dual leaching circuit for several years to enable it to treat refractory custom ores.
5. In South Africa, the standard sequence is to process the gold-uranium ores first for gold recovery then process these tailings for uranium recovery. It has been found that reversing the sequence and acid leaching the ores first for uranium recovery can improve the gold recovery.

The Canadian Blind River ore, a quartz-pebble-conglomerate, requires a high free acid concentration for uranium leaching. After leaching, it is necessary to lower the free acid concentration to the leach liquor prior to ion exchange by neutralizing the leach pulp with lime. Ten mills constructed in the Algom-Elliot Lake area have installed acid liquor recovery circuits in which the leach pulp, at slightly over 60 percent solids, will be filtered on disk filters and the highly acidic liquor returned to the leach to be reused. The filter cake, at around 20 percent moisture, will be repulped with mill liquor and sent to countercurrent decantation or filtration. The 20 percent moisture or liquor remaining in the filter cake will contain the uranium bleed-off



Some unique developments have occurred in leaching uranium ores. The Australian Port Pirie uranium plant (above) leaches a refractory iron-titanium-uranium mineral at boiling temperatures with strong sulfuric acid solutions. Subsequent steps insure that all of the titanium is precipitated at a desirable point in the flowsheet

from the leaching circuit. Recirculating the highly acidic liquor in leaching will give substantial savings in the acid and lime requirements.

Only two or three of the mills have attempted to operate this acid savings circuit. One mill, Consolidated Denison, is using it and apparently quite successfully. Opinions still differ among the various operators on whether the circuit is economically desirable, due to its inherent operating and maintenance costs, which some feel may approach the savings in chemical costs to the operation.

One of the apparent attractions for carbonate leaching is that the solutions are non-corrosive. However, for over four years of operation, the Beaverlodge mill of Eldorado Mining and Refining Co. was plagued with corrosion occurring in its carbonate circuit, particularly in the leaching autoclaves. This was partly attributed to a high sulfide ore and partly to other causes. Formerly the carbonate-bicarbonate content of the Beaverlodge liquors was maintained so the pH was around 9.0. Investigative work showed that the corrosive characteristics of the liquors disappeared above a pH of 9.5 so now the pH of the Beaverlodge liquors is maintained around 9.7 and the corrosion troubles are reported to have ended.

The success of carbonate leaching of uranium ores is dependent on oxidizing and /or maintaining the uranium in the hexavalent state. This can be accomplished by keeping as high an oxygen concentration as possible in the solution by good aeration and/or by pressure. In most plants using carbonate or alkaline circuits, due to weaknesses in leaching design and the desire for maximum capacity, it has not been possible to maintain sufficient oxidizing conditions with air only. From one to over five lb of $KMnO_4$ per ton was found to be the best supplement. This is an expensive reagent. A. D. Little Co., under a research contract with the Division of Raw Materials, AEC, made an extensive survey of other possible oxidants, but found few suitable ones to consider until the combination of ammonia and copper in solution was found to have good oxidation properties for uranium. Further investigation of this phenomenon by the National Lead Co., another Division of Raw Materials Research Contractor, led to the development of Cu-NH_3 oxidation technique for carbonate leaching of uranium ores where, with concentrations of around 0.5 grams per liter of Cu and three grams per liter of NH_3, uranium leaching and recovery rates in carbonate circuits are substantially improved along with important savings in reagent costs.

Ion Exchange

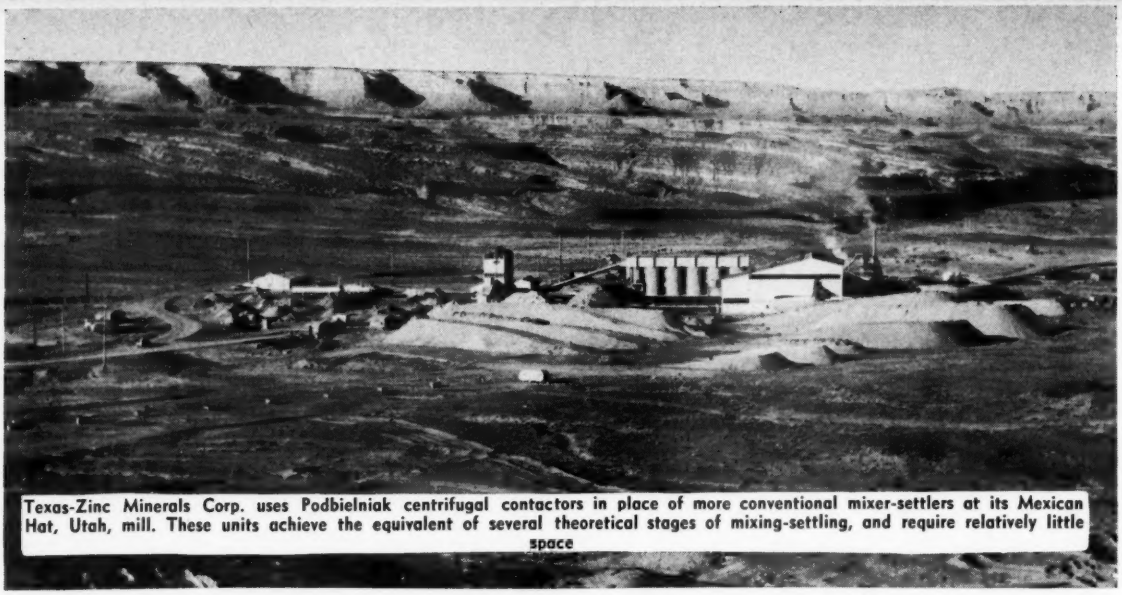
In comparing solvent extraction and present ion exchange techniques for uranium recovery, solvent extraction is used as a true counter-current process where maximum efficiencies can be made of solvents and chemicals, while ion-exchange still tends to be a batch or semi-continuous process. With the development of successful methods for easily moving resins counter-currently with liquors, ion exchange should enjoy a renewed popularity. Some significant advances have been made in this respect:

1. Six of the Canadian uranium mills in the Algoma-Elliot Lake area and the Lucky Mc mill in Wyoming, are hydraulically moving the resin beds from one ion exchange column to another. Each ion exchange unit consists of two sets of these columns in series for loading or removing the uranium from the pregnant liquor and one set of three columns in series for eluting or removing the uranium from the resins. A loaded resin bed is transferred to an elution column for uranium removal, then after elution back to one of the loading columns. For the same uranium capacity, this method requires less columns, makes more efficient use of resin, and chemical consumption for elution and precipitation is substantially reduced. It does appear that labor and maintenance costs may be higher for the moving beds, but the resin is kept cleaner and the resin breakage one might expect seems to be negligible.
2. Two experimental units developed for resin-in-pulp ion exchange uses a counter-current approach. One unit is the Higgins contactor in which the resin is hydraulically moved in slugs countercurrent to the liquors around a loading-washing-exhaustion loop. A 12-in diam experimental model operated successfully with a six percent solids, minus 325 mesh, pulp feed at the AEC'c Grand Junction pilot plant. The other is the Weiss-Swinton column which uses a 20 percent solids feed that moves counter-currently to a loading resin bed. The resin beads remain suspended in the upper half of the vertical column in the thick pulp and are fluidized by a jigging action. As the resin beads become loaded with uranium their specific gravity increases and they settle to the bottom of the column where they are pumped to a washing screen and a separate elution circuit. A four-ft. diam prototype unit is to be installed at the Australian Rum Jungle mill for a trial operation.
3. The Trace Elements mill at Maybell, Colo., has been the first to employ a continuous counter-current resin-in-pulp type process. The resin is mixed in a contactor with the pregnant slime pulp, the mixture is air lifted from the contactor and the resin screened from the pulp and advanced to the preceding contactor with the pulp going to to the succeeding contactor, countercurrent to the flow of resin. The loaded resin is washed and sent to a similar eluting circuit where it is stripped of uranium and recycled to the last tank in the exhaustion circuit. The advantages of this circuit over the basket resin-in-pulp circuit are that a pulp of higher percent solids can be treated which is more efficient and requires less mill water; the resin inventory is smaller and the less costly unsized resin beads can be used; less maintenance is required, and more efficient use of chemicals gives lower costs.

It has been recognized for some time, along with successful pilot plant demonstrations, that alkaline resin-in-pulp (R.I.P.) is an economically feasible process, particularly for slimy uraniferous ores containing appreciable vanadium and lime. Vanadium interference in alkaline ion exchange is eliminated by the vanadium changing to a non-interfering species at an alkaline pH of around 10.5. Early in August 1958, the basket resin-in-pulp circuit of the Government-owned mill at Monticello, Utah, was converted from acid R.I.P. to alkaline R.I.P. The success of this conversion will be watched with keen interest by other uranium mill operators.

There are two changes that merit mentioning in ion exchange elution, or the removal of the adsorbed uranium from the resins. The first is the trend toward sodium nitrate elution instead of ammonium nitrate elution in the U. S. mills. Beside a small chemical cost savings, there are other reported advantages such as lower sulfate contamination of the uranium concentrate, increased bulk density of the dried concentrate and simplification of resin regeneration by using a caustic sodium nitrate solution.

The other recent change in ion exchange elution is the adoption of the Eluex process at the Edgemont mill. This process was developed by National Lead Co. at the AEC's Grand Junction pilot plant. Briefly, the ion exchange resin is eluted with eight to ten percent sulfuric acid. This pregnant eluate then passes through a solvent extraction circuit where the uranium is extracted by di-2-ethylhexyl phosphoric acid (EHPA) in kerosene, and the barren sulfuric acid solution is either used for leaching or reused for elution. The uranium is stripped from the organic solvent with



Texas-Zinc Minerals Corp. uses Podbielniak centrifugal contactors in place of more conventional mixer-settlers at its Mexican Hat, Utah, mill. These units achieve the equivalent of several theoretical stages of mixing-settling, and require relatively little space

a sodium carbonate solution and is precipitated by conventional procedures. One of the principal advantages of the Eluex process is that the nitrate or chloride which is used for elution in conventional ion exchange is eliminated from the circuit. This minimizes chemical pollution problems for the mill effluents and makes reuse of the tailings pond water possible in the mill's circuit.

Solvent Extraction

In examining liquid-liquid solvent extraction, one finds that mixer-settlers are usually used throughout the uranium industry by those mills that employ solvent extraction processes. There are variations in design with the most novel and quite successful one consisting of placing the mixing compartment within the settling tank forming what is known as the internal mixer-settler. Also large tanks have been partitioned to form several mixing and settling stages within the one tank. A departure from using some version of mixer-settlers has been that of Texas Zinc Minerals Corp. which uses Podbielniak centrifugal contactors at its Mexican Hat, Utah, mill. These units achieve the equivalent of several theoretical stages of mixing-settling within a contactor which has a high capacity for a small operating space.

It should be mentioned that the two Florida phosphate operations which recover by-product uranium from their phosphate liquors use liquid-liquid solvent extraction and employ centrifugal contractors (Sharples units).

Because of its association with uranium recovery one could expect solvent extraction to be applied to vanadium recovery. This now has occurred with uranium-vanadium producers of the Colorado Plateau either utilizing or evaluating solvent extraction processes for vanadium recovery. The Shiprock, New Mexico mill of Kerr-McGee was the first to recover vanadium by liquid-liquid solvent extraction. More recently two other uranium-vanadium mills have incorporated solvent extraction in their vanadium recovery circuits. Generally, the vanadium is extracted from the acid liquor following uranium extraction. However, test work at the U. S. Bureau of Mines in Salt Lake City has demonstrated that by using a combination of solvents in an organic carrier, it is possible to co-extract both uranium and vanadium and then co-strip them from the organic solvent with a carbonate solution. The scheme finds application in a mill using the classical synthetic carnotite precipitation for uranium recovery and is now being used at Vanadium Corporation of America's Durango mill.

For some time, research has been directed towards developing a simple process which will permit an economic preparation of an acceptable refined uranium salt or oxide at the mill. During the past year (1958) the AEC's Winchester Laboratory, operated by National Lead Co., has developed a process which should make this possible. A dense metal grade UF_4 suitable for the production of uranium metal can be prepared chemically from clarified sulfuric acid solutions resulting from leaching uranium ores or concentrates.

A kerosene solution containing a secondary or tertiary amine is used to selectively extract uranium from the aqueous leach solution and the uranium is stripped from this solvent with a two or three molar hydrochloric acid solution. Hydrofluoric acid and cupric sulfate are added to the pregnant strip solution and SO_2 bubbled through this heated solution. The copper acts as a catalyst for the reduction of uranium which, as it is reduced, precipitates as a hydrated UF_4 ($UF_4 \cdot \frac{3}{4} H_2O$) as it is reduced. It is then necessary to dehydrate the $UF_4 \cdot \frac{3}{4} H_2O$ to UF_4 by heating under appropriate air flushing conditions. The UF_4 thus produced meets metal grade purity and physical specifications.

Upgrading and Concentrating

For the sake of reducing ore haulage costs and improving mill economics, uranium ore upgrading and concentrating has received increased attention during the past few years. In addition to Vanadian Corporation of America's Monument Valley concentrator which has operated for several years, there are now three more distinct concentrating operations, each processing from 200 to 300 tpd of ore. Besides making a conventional sand-slime separation, two of the concentrators, those of Union Carbide Nuclear Co. at Slick Rock, Colo., and Greenriver, Utah, acid leach the sands before discarding them. The leached values are precipitated by neutralizing the liquor and combined with the slimes prior to drying. At the other concentrator, that of COG Minerals Corp. in White Canyon, Utah, a uranium rich copper sulfide concentrate is recovered by gravity and flotation prior to making a sand-slime separation for further uranium recovery. Trace Elements' mills, Maybell, Colo., uses

a sand-slime separation concentrator in its mill circuit and Climax Uranium Company's mill in Grand Junction has done this since it started in 1951. Climax also acid leaches the sands for metal recovery.

Many other producers have experimented with upgrading, or concentrating, and one can anticipate a continued keen interest in this, particularly in the more remote areas.

Uranium Precipitation

The bulk density of the packaged uranium concentrate produced by conventional ion exchange techniques is relatively low, ranging from 60 to 85 lb per cu ft. The Faraday operation in Canada is unique in that it is consistently producing a uranium concentrate with twice the bulk density produced by other operations using ion exchange. This is important since it means substantial savings in packaging costs. Faraday personnel have no explanation for this curious anomaly other than a very high sulfate level (110 to 130 grams per liter) is maintained in the elution circuit. However, the correlation on changes in bulk density of the uranium precipitate with changes in sulfate level have not been good. However, Faraday's precipitation technique is unique. In that mill the acid eluate and MgO slurry are, for all practical purposes, added simultaneously to the precipitation tank so that the uranium precipitation environment is maintained at a much higher pH than at any other mill. Perhaps this is the reason.

Tailings

Pollution control makes it necessary for many uranium mills to neutralize their plant effluents with hydrated lime. Some plants neutralize their plant liquors and leached tails separately and considerable trouble occurs with gypsum scale build-up in the liquor neutralization system. Those plants which combine their liquors and ore tailings prior to neutralization have a much easier time and scale build up in the neutralizing apparatus is minimized, because most of the gypsum seems to precipitate on the sand particles rather than on the equipment. The South African operations have found that aeration for the neutralizing agitation causes less scaling troubles than mechanical agitation and a holding time of several hours is beneficial. One of the Canadian mills, Faraday, puts a thick coating of heavy grease on the inside of its neutralization tanks which permits a quick clean-off of scale when this is periodically necessary.

The Faraday mill successfully uses the "bug" which is a moving plug with cutting vanes and spinners that is forced through a pipeline, to remove scale from inside its tailings line. The "bug" is similar to the South African "hedgehog" pipe cleaner which consists of a rigid ball fitted with spikes or teeth that is hydraulically pushed through pipe and tailings lines to remove scale and debris. A small radioactive charge of cobalt is put in both the above pipeline cleaners so they can be followed or located with a counter.

Sand-Slime Separation

The advent of resin-in-pulp ion exchange resulted in various approaches to sand-slime separation. The uranium mills are using spiral, rake, or drag classifiers in series along with some combination of cyclones. A novel approach to sand-slime separation by using a low-pressure cyclone cascade was devised by Australian Rum Jungle mill personnel. The cascade consists of a series of alternating mixing tanks and cyclones which are arranged vertically and are fed from a main sump. The circuit is practically self-balancing and self-correcting with all mixing tank overflows returning to the feed tank via an overflow main. A mixing tank, of course, will only overflow in case of stoppage or high surges. The main feed sump has an automatic feed control which shuts off or lowers the feed rate in time of trouble, such as a mixing tank overflowing, and tends toward a self-controlled operation. A large scale pilot unit operated at the Australian Rum Jungle mill gave good performance and exhibited excellent sand-slime separation and sand washing characteristics. Such a unit is able to produce a much higher density slime pulp than can be achieved in the conventional classifier and cyclone circuits and is a cheaper installation. If necessary, two or more cleaner cyclones can be installed, by cascade, to obtain a closer sized overflow product.

In all probability, the future significant developments in uranium ore processing will not be so much in new process technology as in operating techniques and equipment design to perform operational functions more suitably and more cheaply. The uranium industry will continue to bear watching for new ideas, developments and methods suitable for other applications.

Presented at the AMC Mining Show in San Francisco, September 1958. Remarks and facts contained herein are relative to that time.

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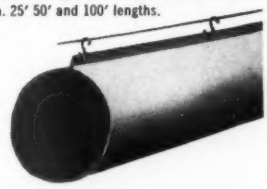

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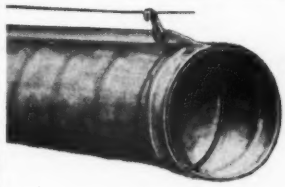

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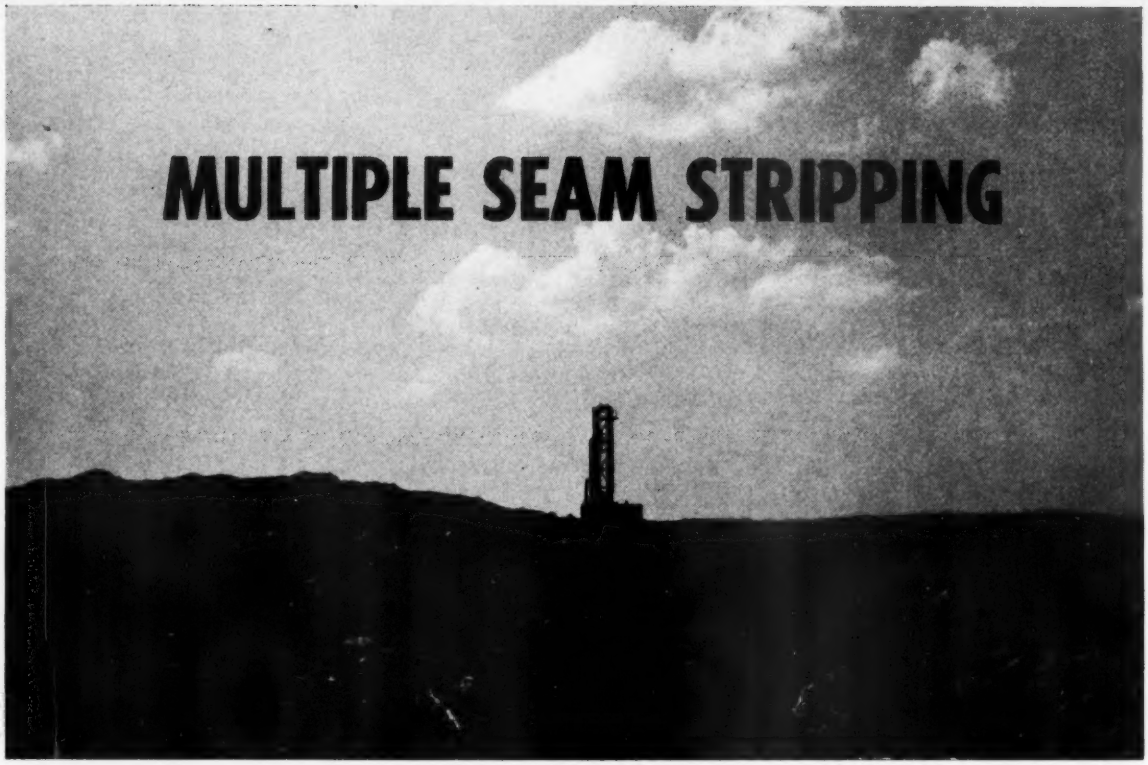

MULTIPLE SEAM STRIPPING

By

O. E. MAY
Manager, Paradise Mine
Pittsburg & Midway Coal Mining Co.

Multiple seam stripping offers several cost advantages over single seam stripping, but it requires closer attention to details and a supervisory force which is prepared to move quickly as operating advantages present themselves

ALL multiple seam stripping operations are probably a special adaptation of present day machinery to a particular set of conditions and materials. This is true of the Paradise Mine. However, there are some general problems connected with this kind of stripping which are common.

Initial Plan Needs to Be Flexible

Operators know approximately the kind and amount of men and equipment needed to strip one seam. Also, to strip in three separated pits of like conditions, it follows that three times the men and equipment would be required. In planning a multiple seam stripping operation, Pittsburg & Midway Coal Mining Co. does not look at the project in this way but rather, because everything is in one pit, tries to use some of the equipment and men for more than one job. Because the seams are on top of each other, the work required in making them available for preparation must follow a regular order. These two requirements are the direct cause of many management problems. However, properly handled, this means economy.

The initial plan needs to be flexible with plenty of manpower and equipment to get the several jobs

All material must be shot for removal at the Paradise mine. Cover is made up from top to bottom of 1–15 ft of clay, up to 55 ft of massive sharp grain sandrock, the No. 13 coal seam which averages four ft in thickness, an average of 18 ft of fire clay and shale, five ft of No. 12 coal seam, fire clay and limestone averaging five ft in thickness and six ft of No. 11 coal seam

(Left) a 750B shovel strips the No. 13 seam of sandrock. In preparing this material for stripping, the company shoots a 20 by 30-ft pattern against a 40-ft buffer, using ammonium nitrate explosives. After stripping, the No. 13 coal is loaded and hauled to the tipple, completing the usual phases of one seam stripping. But there are two more seams to mine, so behind the No. 13 loading, the company starts drilling and shooting the interval of burden between the No. 13 and No. 12 seams

(Below) a 21-yd dragline strips the middle or No. 12 seam from a travel way made on the spoil of the shovel. The interval between the No. 13 and No. 12 seams of coal is composed of fire clay and shale which is too hard to dig easily without shooting but the best of dragline material when "shook up" a bit. It is drilled with an auger and shot with ammonium nitrate exlosives

done in the order required and on time.

Management Problems Multiply

The tendency is to underestimate the problems that will arise rather than overestimate them. There are problems in the management of men and tools in the pit and preparation plant, and the proper correlation of all these is necessary for good production. Also, cooperation between sales and production is necessary to make the whole operation work efficiently.

In multiple seam stripping, problems do not begin and end with the mining phase of the operation. The washability, quality and market of these coals must be established. Blends are a desirable possibility. Management must decide if it will mix coals raw and then wash, or wash first and mix later. The end result will be different. Management must decide how it is to maintain quality of blends and must daily decide which seam to load. The company must manage to keep all kinds of coal on hand at all times. The sale of all coal in the quantities available in the seams is quite a problem in itself, particularly if done in the even, orderly way that will make production efficient.

Proper timing of shifting of equipment requires good judgment and alertness and is a constant demand upon the supervisor's ability. Money can be saved by shifting men or machinery at the proper time. Mistakes will cost. Even repair jobs can be orderly if done at the right time, but often, when forced by a breakdown, they go into overtime and round-the-clock work. This is because

Two rock drills drill the overburden of fire clay and limestone above the No. 11 seam of coal

Coal from the No. 11 seam is being loaded into trucks. Note the shelf at the No. 13 seam to catch falling material

in multiple seam stripping the work has to be done in regular order from the top to the bottom of the pit.

Haulage becomes a problem because part of the roads are used for such a short time. They, of necessity, must be of a temporary nature and, in long periods of rain, can become next to impassable. In the pits at the Paradise Mine much hauling must be done over temporary roads on fire clay. At the exits and entrances to the pit, the roads are consecutively at the elevations of the three coal seams and in the same location. When last used at the elevation of the bottom seam, the roads are made permanent.

What Are the Elements of a Good Multiple Seam Stripping Job?

1. Make the plan of operation flexible. Be sure to have ways and means of doing all jobs in order and on time with some capacity to spare.
2. Management must continually make detailed plans of its pit work as far in advance as it takes time for all machines to pass a given point in the pit. However, management must be willing to change its plan as required if an unavoidable condition arises which dictates change.
3. An alert supervisory force is necessary for an efficient multiple seam operation. It requires closer attention than a single seam job and supervisors must take advantage of every opening and condition to accomplish the work. They must use sound judgment in timing their moves.
4. Plenty of transportation and communication facilities is a must. Pickup trucks for the supervisors, equipped with two-way radio for communication with the stripping machines, shop, office, store room and preparation plant, will give the close contact the job demands.
5. The production crew must learn to cooperate with the sales force. Good relations here will help in operating the mine efficiently. It takes close cooperation to sell and produce the right coal at the right time, in the right quantity. Some cooperation is required between production and sales in order to have the kind of coal needed when the customer demands.
6. Management must be willing to accept some inefficiencies to gain the advantages of multiple seam stripping. All phases of the operation will not be ideal, but the disadvantages, when balanced against the advantages, often become acceptable.

An aerial view of the pit shows that the company is stripping an island of coal. A haulageway has been constructed around the coal body and roads enter the stripping area at 1000–1200 ft intervals. Note that there are no pit ends; coal is mined in an ever tightening circle

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TRAINING MAINTENANCE PERSONNEL

(*Continued from page 58*)

was brought into the classroom and live demonstrations of trouble-shooting were performed by each mechanic. In this phase of the training a class member located, removed, or repaired electrical faults which were placed on the machine by the instructor and the remaining class members. He then operated each function on the machine to prove his work. Each mechanic was drilled in this manner for as many times as class time would permit.

At intervals during the training program true-false and multiple choice tests were given to help determine the progress of the class. At the conclusion of the first portion of the program, similar tests were given and, using results of these tests and the opinion of the instructor, the men were paired off according to their needs and were brought back to the classroom for additional instructions.

In the second portion of the course, instructions were given in burning and welding, and those who merited it were given additional training in the function and repair of electric motors.

Psychological tests to determine intelligence quotient and mechanical aptitude were also given to all class members. The ratings of each mechanic in these tests coincided very closely with the rating compiled from their classroom performances.

Cost of Program—$15,000

Because of these findings management believed similar testing for alplicants for mechanic jobs would help considerably in determining their qualifications. In fact, just recently six men were added to the company's force of mechanics after taking similar tests. The opportunity to take these tests was offered to all mine employes and 28 responded. Test results, previous work performance, length of service at the mine and general attitude were all considered in making the final selection. These men were put through the classroom training program and at the present time are working as apprentices with repair crews. Needless to say their progress is being watched with great interest.

Cost of this training program, including classroom, classroom fixtures, necessary teaching implements and wages, was about $15,000. The company has no way of determining a monetary return on this investment but maintenance supervisors who have followed up the program by close observation of the work habits of these men are certain that they are much more capable of coping with electrical troubles; that they approach such troubles with confidence; and that they seldom find it necessary to call for help.

KOLBE WHEEL EXCAVATOR

ONE of the Nation's largest exclusive strip coal mining companies, the United Electric Coal Companies, is operating four mines in Illinois. During its 41 years of operation it has pioneered important new developments in strip mining practices and equipment. Probably the most dramatic new development which the company is responsible for is the Kolbe Wheel Excavator.

The Problem at United Electric

Fluctuating output in strip mining has been a problem because of unequal stripping depths. Moving a given quantity of overburden does not uncover a uniform tonnage of coal when the overburden thickens. As a result, the mining equipment and organization geared to capacity production may not be utilized to its full rating.

United Electric's engineers found that a shovel-dragline combination was not the most satisfactory solution to this problem at the company's mines. The instability of the top part of the bank, a glacial drift, makes working a dragline near an open face a hazardous operation. This same instability makes it necessary to deposit spoil as far from the face as possible to prevent slides in the pit.

The Kolbe Wheel Excavator overcomes both of these objections because it travels on top of the coal and places the dug material as far back as the fourth and fifth previous cuts.

First Wheel Employed at Cuba Mine

Frank F. Kolbe, president of United Electric, decided to try a wheel excavator. He and his engineering staff developed a machine with a capacity of 1000 cu yd an hour, and it was put into operation in 1944 at the Cuba Mine.

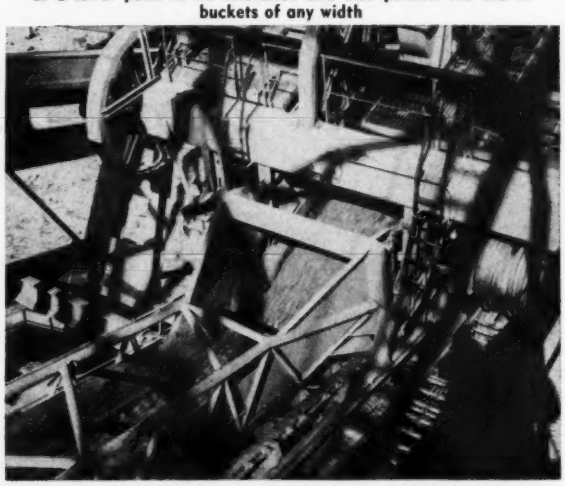
During the following 15 years, three wheels were built, each larger than the previous unit and each incorporating structural and engineering improvements developed by United Electric engineers from the hard test of practical operating experience.

The newest Kolbe Wheel can dig

Cuba mine, location of the new Kolbe Wheel Excavator, is currently producing in excess of 800,000 tons of coal per year. Note the shovel in the background. The Wheel is used to remove the upper part of the overburden, while the shovel handles the remaining portions

The digging wheel is 27 ft in diameter; weighs 90,500 lb; carries ten buckets, each with a 2.5 cu yd capacity; and operates at a speed of eight rpm

Roll feeder over which excavated material is discharged from the digging wheel to the ladder belt. The roll feeder construction makes it possible for material to come out of the wheel at a lower point in its revolution and also permits the use of buckets of any width



Transfer point. Material discharges from the ladder belt at 910 fpm to the stacker belt moving at 1225 fpm

Specifications and Performance Data of Kolbe Wheel Excavator

GENERAL

Over-all length (maximum)	420 ft
Width at center of rotation	46 ft
Roller circle diameter	45 ft
Height of discharge point above coal	119 ft 3 in.
Excavating range above coal (low)	9 ft 0 in.
(high)	100 ft 0 in.

DIGGING WHEEL

Diameter	27 ft
Number of buckets	10
Bucket capacity	2.5 cu yd (bank measurement)
Rotational Speed (variable) normal	8
Swing speed at digging point	50–80 fpm
Maximum capacity at 18 in. depth of cut	4800 cu yd/hr
Maximum depth of cut possible	36 in.

BELTS

Ladder belt width	60 in.
length	245 ft
speed	910 fpm
Stacker belt width	60 in.
length	700 ft
speed	1225 fpm

ELECTRIC POWER

Motor-Generators	2 @ 900 hp each
Wheel drive motor	715 hp @ 660 rpm
Ladder belt drive motor	250 hp @ 1200 rpm
Ladder crowd drive motor	100 hp @ 430 rpm
Roll feeder drive motor	40 hp @ 1170 rpm
Stacker belt drive motors	2—400 hp @ 660 rpm
Swing drive motors	2— 35 hp @ 700 rpm
Propel drive motors	4—150 hp @ 1200 rpm

SPEED REDUCERS

Wheel drive	83.14 to 1
Ladder belt drive	3.97 to 1
Stacker belt drive	10.076 to 1
Crowd drive	4.38 to 1

Crawler drive from 1200 rpm motor speed to 14 fpm

WEIGHTS

Wheel complete with motor and drive	215,500 lb
Total weight of ladder and wheel	476,000 lb
Total weight of machine on crawlers	2100 tons

3500 cu yd per hour of overburden up to 100 ft above the coal bed and convey it 420 ft to the spoil bank.

Many Problems Had to be Solved

Many problems had to be solved in developing the Kolbe Wheel, but let us consider two particular interesting examples. It was found that in winter wet material would freeze to the belts even at the theoretical maximum speed of 600 fpm for rubber belts. Neither scrapers nor heating devices licked the problem until, perhaps by hunch, ladder and stacker belts were speeded up to 900 fpm, moving too fast for the material to freeze.

Now ladder and stacker belt speeds up to 1225 fpm are practical, but high speeds create another problem. Boulders weighing up to 1½ tons each, moving at speeds up to 1000 fpm, imposed intolerable impact loads on the conveyor idlers. Extremely rugged suspension idlers were developed by United Electric engineers to solve this problem.

Interesting Details of New Machine Examined

The new Kolbe Wheel has a maximum over-all length of 420 ft and a total weight of 2100 tons. Height of discharge point above the coal is 119 ft 3 in. and the excavating range above the coal is 9 ft (low) to 100 ft (high).

Digging Wheel. The 27-ft diam digging wheel carries ten 2.5 cu yd buckets and has a speed of eight rpm. The wheel is powered by one 715-hp motor at 660 rpm continuous and 1200 hp at peak kw. Variable speed control permits regulation for different conditions but eight rpm is considered normal speed. Motor drive is a 30-in. Poly-V belt which helps provide the necessary clutching action to protect motor and reducer against shock loads. The wheel itself weighs 90,500 lb while the entire digging assembly, including all machinery, weighs 476,000 lb. A chain mat in the back of each bucket provides continuous self-cleaning.

Roll Feeder. Excavated material is discharged from the wheel to the belt over a roll feeder. This allows the buckets to start dumping at a low position and also permits the use of buckets of maximum width. The four rollers rotate at speeds increasing from wheel to belt, the roller nearest the belt turning at 44 rpm. The roll feeder construction makes it possible for material to cascade onto the 910 fpm belt without piling up.

From Ladder Belt to Stacker Belt. Excavated material discharges from the ladder belt at 910 fpm onto the stacker belt moving at 1225 fpm.

(*Continued on page 75*)

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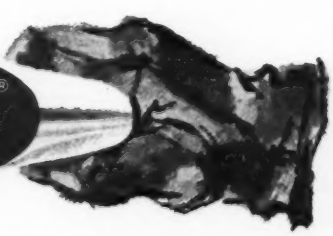

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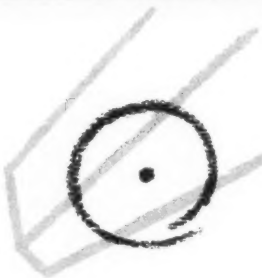

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You can select from eight different shapes to find the point that matches your digging conditions. *ESCO* Points are designed by bucket and excavation specialists who know how to achieve top digging performance. The self sharpening design of an *ESCO* Point makes it start sharp and stay sharp.

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Your local ESCO dealer can supply Points and Adapters for all your digging needs. By using ESCO Points and Adapters on all your equipment you can cut costs further by reducing your point inventory and consolidating purchases. Call your ESCO dealer today for details. He's listed in the yellow pages of your telephone directory. Or, write direct.

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ESCO Point shapes . . . start sharp, stay sharp and last longer under any digging condition.

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Operators' Corner

BLASTING AIDS

HIP POCKET

BLASTING COST CHART

Location of blast: _____

Date _____

Loading Details	Comparison Blast	This Blast
Number of holes		
Diameter of holes		
Average Depth		
Average Spacing		
Average Burden		
Average Stemming		
Type of Initiation		
Point of Initiation		
Delay Pattern		
Pounds of Explosives		
Type:		
Type:		
Type:		
Total		
Cu. Yds. Produced		
Tons Produced		
Powder Factor Yds./Tons / lb. Expl.		

Drilling	Comparison Blast	This Blast
Labor		
Equipment Amortization or Rental		
Power or Fuel		
Bits and Steel		
Maintenance		
Total Drilling Cost		
OR was the drilling cost of both blasts about the same?		
Primary Blasting		
Labor		
Equipment (if any)		
Primary Explosives		
Primers		
Blasting Supplies (caps, primacord, wire, etc.)		
Total Primary Blast Cost		

Secondary Breakage	Comparison Blast	This Blast
Labor		
Equipment		
Secondary Explosives		
Blasting Supplies (caps, fuse)		
Total Secondary Breakage		
OR was the amount of secondary breakage about about the same?		
Digging, Hauling, Crushing		
Estimated cost of digging		
Estimated cost of hauling		
Estimated cost of crushing		
Special maintenance or any other extra costs traceable to blasting performance		
Total DHC Cost		
OR was above cost about equal for both blasts?		
Total Cost of Blast		
Cost per Yard or Ton		

Comments	Comparison Blast	This Blast
Backbreak?		
End break?		
Uniformity of breakage?		
Control of throw?		
Noise?		
No. of complaints?		
Toe or high spots?		
Height of muck pile?		
Other comment:		

Consumers representative in charge _____

Explosives representative assisting _____

THREE new aids to efficient blasting offered by Atlas Powder Co. are designed to be used right on the job.

Small enough to fit in shirt or hip pocket, the Hip Pocket Blasting Cost Chart provides a way to make quick orderly cost records while drilling, loading and shooting a blast. It can be used for comparison purposes to determine what methods are most economical, and, for many jobs, it will provide an adequate permanent cost record. Operators with larger record-keeping and accounting facilities will find the pocket size chart useful to collect information for later transfer to the file chart or to their own books.

A companion piece, the Hip Pocket Loading Chart, provides the same sort of on-the-spot record of the blast loading pattern. On one postcard size chart there is space for all data of burden, spacing, powder, stemming and detonators for a blast of up to 20 drill holes.

In addition, a Blast Summary card is provided for explosives users who want, or are required by law, to keep a brief general record of each blast. Enough space is provided on one card to record 11 blasts, showing number of holes fired, average depth, hole diameter, spacing, burden, total explosives, firing pattern, tons or yards of rock, and brief comment.

All three pocket size charts are printed on heavy stock to stand up in the hand outdoors without needing any backing.

Charts are available from Explosives Division, Department CR, Atlas Powder Co., Wilmington 99, Del.

HIP POCKET LOADING CHART

Consumer _____

Date _____ Location _____

Hole No. Vertical ☐ Horizontal ☐ Diameter in.	Height of Face (Ft.)	Depth of Hole (Ft.)	Spacing (Ft.)	Burden (Ft.)	Explosives: Grade / Pounds	Explosives: Grade / Pounds	Explosives: Total per Hole	Stemming (Ft.)	Type Detonator / Delay Period

Time Loading Started _____ Finished _____ Fired _____

Type of Blasting Machine _____

Leading Wire _____ Connecting Wire _____

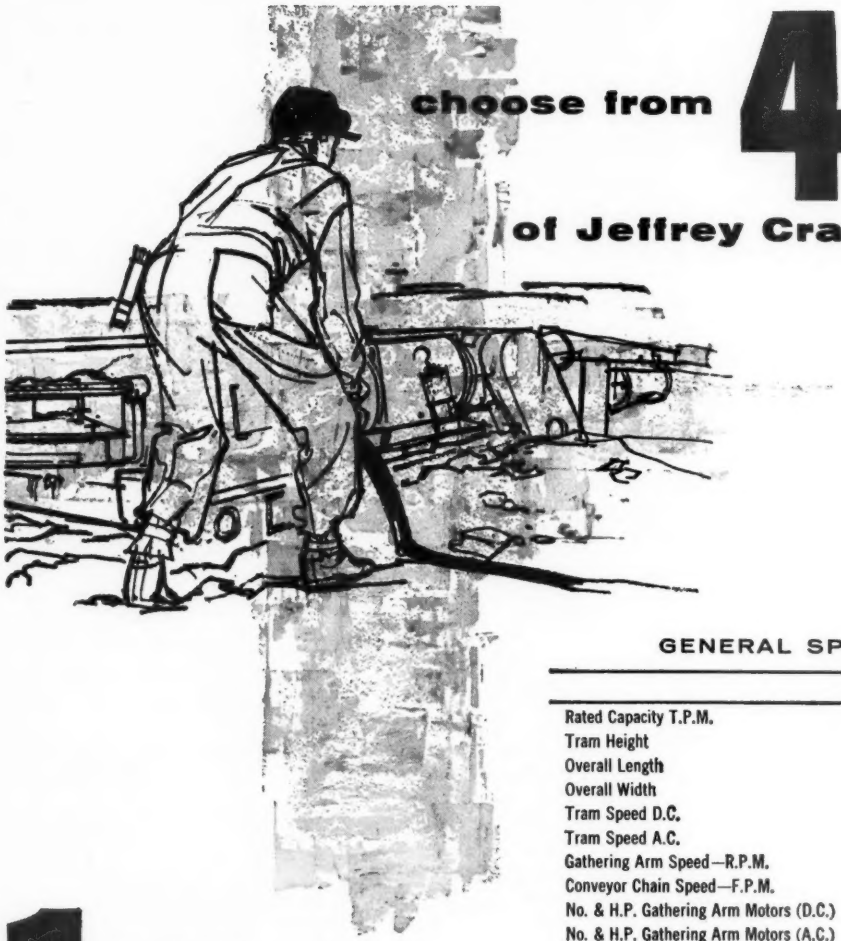
Plan of Connections _____

BLAST SUMMARY

Consumer _____ Location _____

Date	No. of Holes	Average Depth	Hole Diameter	Spacing	Burden	Total Powder	Cap Pattern	Tons or Yards	Comment

choose from 4 types of Jeffrey Crawler-Loaders



GENERAL SPECIFICATIONS

	81-C	81-AL	81-AH	97-A
Rated Capacity T.P.M.	10	10	10	18
Tram Height	25″	32″	36″	43″ or 48″
Overall Length	25′-8½″	24′-1″	24′-1″	25′-11″
Overall Width	7′-5¼″	7′-5¼″	7′-5¼″	7′-8″
Tram Speed D.C.	137	137	137	160
Tram Speed A.C.	85	85	85	160
Gathering Arm Speed—R.P.M.	55	55	55	53
Conveyor Chain Speed—F.P.M.	372	372	372	360
No. & H.P. Gathering Arm Motors (D.C.)	2—15	2—15	2—15	2—25
No. & H.P. Gathering Arm Motors (A.C.)	2—20	2—20	2—20	2—33
No. & H.P. Conveyor Motors (D.C.)	Uses Gathering Arm Motors			2—10
No. & H.P. Conveyor Motors (A.C.)	Uses Gathering Arm Motors			2—20
No. & H.P. Tram Motors (D.C.)	2—15	2—15	2—15	2—25
No. & H.P. Tram Motors (A.C.)	2—20	2—20	2—20	2—33/8.25
H.P. Pump Motor—A.C. or D.C.	4	4	4	8
Weight in lbs. approx.	21000	21000	21000	38000

Voltages: Loaders can be built for operation on any of the following voltages: 250 or 500 V, DC; 440 V, AC, 3-ph., 60-cy, 415 V, AC, 3-ph., 50-cy.

1 height

Four loaders with five heights, means you can put the correct height loader in the seam height for which it's designed. This assures proper clearance for lumps and convenient height of controls for the operator.

2 power

Available for direct current or alternating current power. Liberal size motors.

3 capacity

Jeffrey Loaders are setting high tonnage records with low maintenance cost and very little down time.

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As Viewed by HARRY L. MOFFETT of the American Mining Congress

LEADERS of the heavily Democratic 86th Congress, stung by Republican "do nothing" charges, have moved to clear several controversial pieces of legislation held up for months, in most cases in Senate-House conference committees. Included in this category are bills to expand Federal aid for airport construction, veterans' and other housing, and education.

Well aware also of "budget busting" accusations, the majority party, particularly in the Senate, is making sure that the measures coming out of conference are toned down enough to permit countering of such charges and to make them less susceptible to Presidential veto.

Congressional concern with the over-all energy picture was again evidenced last month with the creation by the Joint Economic Committee of an Automation and Energy Resources Subcommittee to study the long-range adequacy of U. S. energy resources. Subcommittee chairman is Rep. Wright Patman (Dem., Tex.); other members are Senators O'Mahoney (Dem., Wyo.), Kennedy, (Dem., Mass.), and Butler (Rep., Md.), and Reps. Reuss (Dem., Wis.), Kilburn (Rep., N. Y.), and Widnall (Rep. N. J.). The new Subcommittee's program has not yet been announced.

CONGRESSIONAL LEAD-ZINC AID DRIVE BEGUN

Well over a score of Senators and Representatives—mostly from the West—have sponsored bills which would place "peril point" import taxes on imported lead and zinc metal, ores, and concentrates as a means of aiding hard-pressed domestic miners of these base metals.

The proposed legislation would revoke the current minor duties, replacing them with import taxes of 4 cents a pound on lead and zinc metal and 2.8 cents a pound on the metal content of ores and concentrates, effective only when the average monthly price of lead falls below 15½ cents a pound or, in the case of zinc, below 13½ cents a pound. Similarly, various compensatory import taxes would be added to present duties on semi-manufactured products of lead or zinc whenever the price of either metal falls below the prescribed level.

Import tax schedules would remain in effect regardless of any trade agreement entered into or modified under the authority of the Trade Agreements Act.

Senator Allott (Rep., Colo.), a sponsor, said the legislation is designed to stabilize domestic mine production of lead at 350,000 tons a year and of zinc at 550,000 tons a year. Other Senators and Representatives emphasized the depressed conditions in the industry, urging early consideration by the Senate Finance and House Ways and Means Committees, to which the bills were referred.

Another approach to solving the vexing problems of the domestic industry was simultaneously taken by Chairman Aspinall (Dem., Colo.) of the House Interior Committee. He introduced a bill to establish a flexible import quota system aimed at maintaining domestic lead-zinc prices at the 15½–13½ cents levels. The measure's quotas, covering ores and concentrates as well as metals, would be more restrictive than those proclaimed last September by the President; they would be based in part upon the difference between domestic mine production and consumption.

Under the Aspinall bill, quotas would be allocated quarterly by the Secretary of Commerce and administered in accordance with the procedure now employed by the Bureau of Customs under the President's lead-zinc proclamation.

This measure was also referred to the Ways and Means Committee.

LABOR BILL MAY REACH HOUSE FLOOR SOON

Following completion of more than three months of hearings, the House Labor Committee is now working on various proposals—including the Senate-passed Kennedy bill—aimed at labor-management reform. The Committee is meeting behind closed doors, and there is little indication as to whether an effective bill will be sent to the House floor.

Washington Highlights

Lead-Zinc: Legislation studied

Labor: Reform bill readied for House

Mining Policies: House hearings begin

TVA: Revised measure to Senate

Fluorspar: Quota bill reported

Price Increases: House committee acts

Minimum Wage: Hearings end

Atomic Power: Reactor program approved

Coal Research: House votes independent commission

Water Pollution: Fund authorizations doubled

During the closing days of the House hearings, Senators McClellan (Dem., Ark.) and Goldwater (Rep., Ariz.) testified on the urgent need for a strong measure to clean up the flagrant abuses within the labor movement disclosed by the Senate Rackets Committee, of which McClellan is chairman.

The Arkansas Senator flatly stated that the Kennedy bill "will not, as it is now written, correct all the evil conditions and improper practices that we know exist . . . it should be strengthened before it is enacted into law." He also called attention to the need for eliminating loopholes in the Taft-Hartley Act ban on secondary boycotts and for banning organizational picketing—neither of which would be accomplished by enactment of the Kennedy bill.

Goldwater declared that if the Kennedy bill becomes law, "the abuses diligently spotlighted by the Rackets Committee will merrily continue and Congress will be charged with having legislated a bill which is a sham at best." He added: "How humiliating it is for the Congress of the United States to have to conduct a sort of treaty-negotiation with a great internal political power almost as with a foreign power to find out what these union grandees, seated in their ducal suites, would be willing to tolerate in the way of mild corrections."

Goldwater's appearance before the Committee followed an announcement by the AFL-CIO which had endorsed the original Kennedy bill, that the big labor union is opposed to the Kennedy bill as somewhat strengthened by the Senate. Other unions are also opposed to truly corrective legislation, and as a result anv bill which finally emerges from the House Labor Committee may be ineffectual.

MINING PROBLEMS AIRED AT HEARINGS

By the time this issue reaches its readers, the House Interior Subcommittee on Mines and Mining will have completed a week's hearings on the problems of various segments of the mining industry, with testimony from members of Congress, State officials, and spokesmen for State mining associations and individual mining industries. Purpose of the hearings was to compile information on the current status of the industry, rather than to develop remedial legislation.

Scheduled for the opening day, June 25, were members of Congress. June 26 was set aside for State and association officials, including S. H. Williston, chairman, Strategic Minerals Committee, American Mining Congress; Miles P. Romney, manager, Utah Mining Association; Robert S. Palmer, executive vice president, Colorado Mining Association; and W. F. Darmitzel, secretary, New Mexico Mining Association.

C. E. Schwab, chairman, and other representatives of the Emergency Lead-Zinc Committee were scheduled for June 29, as well as a spokesman for the International Union of Mine, Mill & Smelter Workers.

F. A. McGonigle, vice president, Howe Sound Co., was slated to appear June 30 in behalf of the domestic cobalt industry; other witnesses were to represent domestic manganese producers.

Witnesses scheduled for July 1 were Merrill F. Shoup, president, Golden Cycle Corp. (gold); Elgin Groseclose, Washington, D. C. (silver); John Edgar, Sunshine Mining Co. (silver and antimony); and Clyde L. Flynn, Jr. (fluorspar).

July 2, final day, was set aside for the coal mining industry, with Frank W. Earnest of the Anthracite Institute scheduled to appear.

Several other witnesses were expected to be added to the final list.

SENATE COMMITTEE AMENDS TVA BILL

The Senate Public Works Committee has reported to the Senate, with several amendments, a House-approved bill which would authorize the Tennessee Valley Authority to issue revenue bonds to finance future power expansion. The measure is now on the Senate calendar.

The House version would have permitted TVA to issue revenue bonds without any budgetary controls by the Treasury Department or the Budget Bureau, but would have generally prohibited TVA from expanding its marketing area beyond present limits. As reported by the Senate Committee, the measure would allow TVA to expand its service area by approximately 2000 square miles.

A measure of financial control was written into the Senate bill, however, in that without Treasury Department approval of the time of issuance and the maximum interest rate of a proposed issue of TVA bonds, TVA could issue only $150 million of such bonds every eight months; the interest rate would be the average rate on outstanding marketable United States obligations. The agency would be required to submit its power program to the President, who would forward it to Congress in his budget estimates together with any recommendation he might deem appropriate. The program would be deemed approved unless rejected within 90 days by Congress. A schedule of repayment to the Federal Government of its appropriation investment was also set out in the measure.

W. W. Bayfield, president of American Coal Sales Association, presented the views of the coal industry at the Senate Public Works hearings on the legislation; his testimony was endorsed by the American Mining Congress.

Early Senate action on the proposal is anticipated.

FLUORSPAR QUOTA BILL MOVES

A bill which would place flexible import quotas on fluorspar was approved in mid-June by the Senate Interior Committee but, as the result of an inter-Committee dispute, it was then referred to the Finance Committee instead of being placed on the Senate calendar for floor action.

Referred originally to the Interior Committee, the measure was the subject of hearings in April; further action was held in abeyance because the Finance Committee then made known its claim to jurisdiction over the bill. An agreement was later reached whereby the Interior Committee would report the bill together with a recommendation that it be referred to the Finance Committee for further study.

Under the measure, flexible quotas would be placed on domestic production and imports of fluorspar, subject to an irreducible domestic allocation of 325,000 tons annually of all grades.

PRICE INCREASE HEARINGS SOUGHT

The House Government Operations Committee has approved a bill to empower the President, or any agency he may select, to hold public hearings in the case of proposed price increases in key industries which threaten price stability. The measure would also authorize the investigation of wage increases if the industries involved claimed that such increases were a major factor in forcing higher prices. The President would be authorized to issue a statement on whether the increases were justified, but he could take no further action under the bill.

SENATE MINIMUM WAGE HEARINGS END

The Senate Labor Subcommittee has concluded lengthy hearings on a bill by Senator Kennedy (Dem., Mass.) which would extend the cover-

age and increase the minimum hourly wage under the Fair Labor Standards Act. Business witnesses opposed enactment of the measure; on the other hand, Secretary of Labor Mitchell urged the Subcommittee to approve extension of the law to those employees of the retail and service trades who are engaged in any business enterprise in which the total annual value of the incoming merchandise, materials, or supplies moving directly across State lines to the place of business is $1 million or more, and in which 100 or more employees are employed. The AFL-CIO asked the Subcommittee to raise the minimum wage to $1.25 an hour and to broaden its coverage to include an estimated 7.5 million workers.

NUCLEAR POWER REACTORS AUTHORIZED

Congress has sent to the White House a bill which would authorize three new civilian nuclear power reactors in addition to the five new atomic power plants requested earlier by the Atomic Energy Commission. Five of the eight plants would be built by the Government and three by private industry. The Government would put up money to pay the costs for research and development of the privately-financed projects.

COAL RESEARCH BILL WINS HOUSE APPROVAL

Almost simultaneously with Senate Interior Subcommittee hearings on the matter, the House passed and sent to the Senate a bill which would establish an independent Coal Research and Development Commission. Prior to passage, the bill was amended to limit the life of the agency to five years and to prohibit the Commission from duplicating research work being conducted by any other Federal agency.

In debate on the House floor, Rep. Fulton (Rep., Pa.) called attention to the fact that the American Mining Congress had declared that greatly increased funds for coal research are necessary to advance coal technology and to meet the heavy demands that will be imposed upon the industry in the future. He also pointed out that Julian Conover, executive vice president of the Mining Congress, had urged the Senate Interior Committee to approve the type of research and development program proposed in the House bill.

Several Senators also called for the adoption of a measure to create an independent commission. Other coal industry witnesses included Harry LaViers, for the National Coal Association, and Fred Bullard of the Kentucky Coal Association. John Owens, secretary-treasurer of the United Mine Workers of America, supported the principles of the legislation, but stated it could be effectively administered by the U. S. Bureau of Mines; similar testimony was given by Marling J. Ankeny, director of the Bureau.

HOUSE PASSES WATER POLLUTION BILL

The House has passed and sent to the Senate a bill to double Federal aid for water pollution control projects. The action followed defeat of an Administration-supported effort to require States to match dollar for dollar the Federal funds, which are now in the form of outright grants.

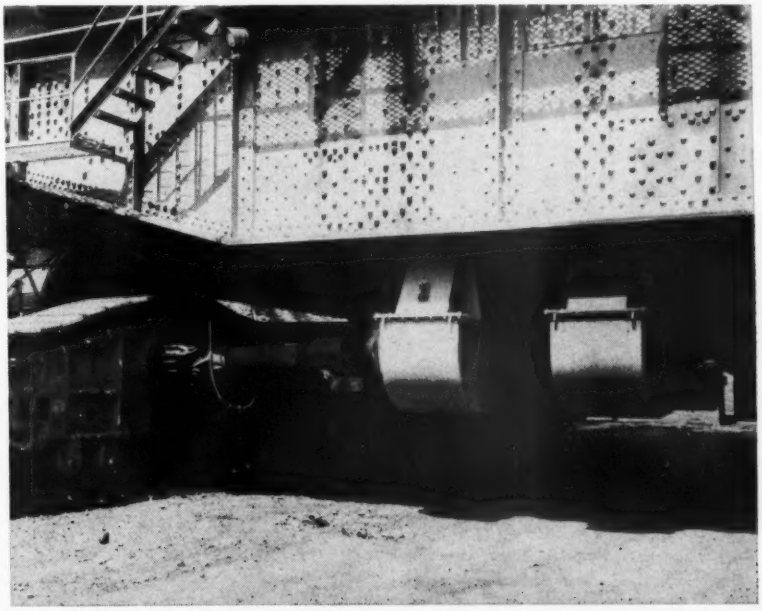
The measure would authorize Federal grants of $100 million annually, as opposed to the present authorization of $50 million, to aid States and municipalities in construction of water pollution control facilities, and would raise the aggregate ceiling on such grants from $500 million to $1 billion. It would also increase from the present $250,000 to $500,000 the amount that could be granted for a single facility, and remove the single-project ceiling where municipalities join in building a single plant serving their combined areas.

KOLBE WHEEL EXCAVATOR

(*Continued from page 68*)

In the earlier machines a great deal of trouble was encountered with shock loads at this transfer point. With high speed belts, suspension idlers and a vertical drop of three ft from top of belt to top of belt, very little trouble is encountered in the new Kolbe Wheel. In this transfer zone of the stacker belt and the loading zone of the ladder belt, suspension idlers are held on a rubber cushion at each end that supplies additional shock resistance. Integral with the ladder are traveling skirt boards over 60 ft long that guard against spillage in the transfer zone.

Suspension Idlers and Stacker Belt. One of the most serious problems encountered in the first three wheel excavators was the fact that large boulders and frozen chunks of top soil bounced and rolled back down the slope of the stacker belt. This problem has been solved by the development of rugged heavy duty suspension idlers. The ability of the idler to depress and swing forward at the same time enables it to ride with the punch of boulders and large lumps. The suspension idlers also simplify the problem of belt alignment because they adjust from off-center loading. The 60-in. stacker belt has a 5-ply, 7/16-in. top cover, including five nylon cord breakers (one longitudinal and four bias) and a 3/32-in. bottom cover, including one longitudinal breaker.



Four 150-hp motors are employed to move the 2100-ton crawler mounted machine

personals

Frank Coolbaugh has been appointed president of Climax Molybdenum Co., Division of American Metal Climax, Inc., succeeding **Weston Thomas** who was elected executive vice president of American Metal.

F. Coolbaugh

The new head of the Climax division worked his way up from the very lowest rung of the corporate ladder, having begun as a miner's helper in the company's molybdenum mine at Climax, Colo. He rose through the ranks and in 1957, at the merger of Climax with American Metal Co., Ltd., was made a vice president and director of the merged company. He also serves as president and director of Climax Uranium Co., San Antonio Mining Co., St. Anthony Mining Corp., and Climax Molybdenum Co. of Pennsylvania, and is a vice president and director of Climax Molybdenum Co. of Michigan.

Prominent in Western mining circles, Coolbaugh was national program chairman for the 1958 Metal Mining and Industrial Minerals Convention of the American Mining Congress which was held in San Francisco.

The appointment of **William K. Dennison** as manager of Kaiser Steel Company's coal property at Raton, N. M., was recently announced. He succeeds **Joe Kastler,** who has retired after 47 years' service in the coal mining industry. Kastler, who will serve as a consultant for Kaiser, began his career as a clerk in 1912 for the St. Louis, Rocky Mountain & Pacific Co. He had risen to vice president of Rocky Mountain at the time it was purchased by Kaiser Steel.

Robert B. Crist, general superintendent of M. A. Hanna Company's Mesabi Range mines, was transefrred in early May to the company's Cleveland office as a general operating engineer. At the same time, **Fred E. Dyson,** superintendent, Cooley District was named to succeed Crist.

Replacing Dyson is **Leroy Clover,** assistant superintendent of the Cooley District. **Donald Nelson** was appointed assistant superintendent.

Quin Morton, III, has been appointed executive secretary of the Kanawha Coal Operators' Association, Charleston, W. Va. He replaces the late Harry G. Kennedy.

Morton most recently has been associated with Kimberling Colleries in Mingo County, W. Va., as general manager, and with Robinson and Robinson, consulting mining engineers.

Robert D. Bradford and **Edward McL. Tittmann** were recently elected executive vice presidents of American Smelting & Refining Co., and **Charles F. Barber** and **Forrest G. Hamrick** were elected vice presidents.

Bradford is president of Lake Asbestos of Quebec, Ltd., Asarco's

R. D. Bradford

E. McL. Tittmann

wholly owned asbestos producing subsidiary, and is in charge of the company's Federated Metals Division.

Tittman originally joined Asarco in 1929, leaving in 1952 to become president of Southern Peru Copper Corp. He returned to the company in 1958 as vice president in charge of smelting and refining operations.

Barber came to Asarco in 1956 as general counsel, leaving his post as assistant to the Solicitor General of the United States. Hamrick joined the company in 1946 as a financial and economic analyst. Since 1957 he has served as treasurer and director.

J. H. Buehler has been elected president of Bristol Silver Mines Co. **Byron S. Hardie** was elected vice president.

R. E. Combs was recently appointed general sales manager of Jewell Ridge Sales Co., Inc. **Delbert E. Lutz** was appointed assistant general sales manager. Combs comes to Jewell Ridge from United Eastern Coal Sales Corp. where he had served as general sales manager.

U. S. Borax Research Corp. has announced two new appointments to its Chemical Engineering Research Department. **M. A. Peters** has joined the department as a research engineer, and **D. L. Sawyer** has been appointed section head of process improvement research, a branch of the department.

Anthony Gentile was recently elected president and general manager of Ohio River Collieries Co. He joined the company in 1957 as manager.

Inland Steel Co. has announced the following personnel changes at its Wheelwright, Ky., properties.

Hobert B. Smith, preparation plant superintendent, has been advanced to superintendent of underground maintenance, replacing **E. C. Willis** who has left Inland to join South-East Coal Co. **Bob Grimm,** preparation engineer, succeeds Smith as superintendent of the preparation plant. **Donald Jones,** assistant preparation engineer, was promoted to preparation engineer.

The Chesapeake & Ohio Railway has announced the appointment of **R. L. Barnett** as special representative in the coal development department with headquarters in Huntington, W. Va.

L. S. Breckon, chief of the land division of Bear Creek Mining Co., exploration subsidiary of the Kennecott Copper Corp., recently ended a 40-year career in the mining industry with his retirement.

In 1925 Breckon became head of the first geological department of the then Utah Copper Mine, Bingham Canyon, Utah. In 1928 he was placed in charge of underground lead-zinc operations for Utah Copper Co. at Bingham Canyon, and in 1932 he headed the Geological Department. He became head of exploration in the Western United States for Kennecott in 1943, and in 1951 he was put in charge of exploration activities in the South Pacific and Far East.

At the recent annual meeting of the Copper Range Co., held May 6, **John P. Lally** announced his retirement as president of Copper Range, White Pine Copper Co. and the C. G. Hussey & Co. Division, after 53 years of service. Lally was then unanimously elected chairman of the board of directors of Copper Range.

Nelson J. Darling was elected chairman of the executive committee of Copper Range to direct the general management of its business until a new president is elected.

William W. Lynch, vice president in charge of sales, Calumet & Hecla, Inc., retired June 1. He had been with the company since 1944.

Robert Henderson, resident manager of Climax Molybdenum Co. since 1954 at Climax, Colo., has been named general manager of Western operations. Henderson joined Climax in 1936.

R. Henderson

Other major management promotions at Climax which have been announced include: the naming of **E. J. Eisenach** as resident manager; the appointment of **John Petty** as general superintendent; promotion of **A. M. Mastrovich** to assistant general manager; naming of **Frank Windolph** as assistant general superintendent, and **Fred Hoff,** mill superintendent.

Alvin D. Grinde, master mechanic of the South Agnew and Morton mines of M. A. Hanna Co., has been promoted to assistant supervisor of mobile equipment.

Maurice F. Dufour has been elected executive vice president and director of Freeport Nickel Co. He is also vice president of Freeport Sulphur Co., parent company of Freeport Nickel.

Appointment of **Fred W. Drosten,** as director of metallurgical development for Heavy Minerals Co. has been announced. He leaves the Atomic Energy Commission, where he was engaged in reactor research, to join Heavy Minerals.

On July 1 **George D. Dub** retired from Cyprus Mines Corp. and as president and general manager of Coronado Copper and Zinc Co. He plans to resume engineering practice in Los Angeles.

James K. Richardson, assistant general manager of the Chino Mines Division of Kennecott Copper Corp., has resigned to accept a position as vice president and general manager of Glover Associates (Canada) Ltd., a management consulting firm. Richardson will remain at Chino long enough to complete present projects under way.

J. K. Richardson

In his new position, Richardson will be in charge of the Glover firm's Canadian operations with headquarters in Montreal. The company also has a number of branches in the United States. Glover Associates (Canada) is one of the oldest management consulting companies in that country.

Associated with Kennecott for the past nine years, Richardson joined the company in Salt Lake City as industrial relations engineer for Kennecott's Western Mining Divisions. In 1952, he was named assistant to the general manager of the company's Utah Copper Division. In 1954 he was transferred to Chino as assistant general manager.

Joseph E. Moody was recently elected president of National Coal Policy Conference. Moody had been executive director of the conference since its formation last February. He is also president of the Southern Coal Producers' Association. **George H. Love,** chairman of Consolidation Coal Co., was named chairman of the conference.

OBITUARIES

Worthen Bradley, 55, president, Bradley Mining Co., passed away at his home in early June. Mr. Bradley was widely known in Western mining circles. He served as Chairman of the Western Division of the American Mining Congress in 1948 and was vice president of the Mining Congress from December 1956.

Frank B. Dunbar, 85, former superintendent of mines for Hillman Coke and Coal Co., died May 21.

During the 45 years before his retirement in 1946, although Mr. Dunbar worked at some of the most gaseous mines in Pennsylvania, there were no fatal accidents in mines under his supervision. He was past president of the Coal Mining Institute of America, and a charter member and past president of the National Mine Rescue Association.

John C. Lincoln, 92, president of Bagdad Copper Co., died in Phoenix, Ariz. May 24.

Mr. Lincoln founded and was honorary chairman of Lincoln Electric Co. at Cleveland, Ohio. In 1944 he purchased a large stock interest in the Bagdad Copper Corp. and served as president from 1944 until the time of his death. It was during his tenure that the decision was made to change the mine from an underground to an open pit operation.

N. R. Denham, 87, mining engineer in Harlan and Bell Counties, Ky., died May 7.

A. Todd Davis, 46, Director of industrial relations for the Nevada Division, Kennecott Copper Corp., died May 18 at Ely, Nev.

Eugene McAuliffe, 92, retired chairman of the board of the Union Pacific Coal Co. passed away in Omaha, Neb., June 2 after an illness of ten months.

Mr. McAuliffe became president of Union Pacific Coal Co. in 1923 and was board chairman when he retired in 1947. He was manager of the Fuel Conservation Section of the U. S. Railroad Administration from 1918 to 1920. Widely known in the mining industry he wrote several books on the coal industry and one of the career of General George Custer. Mr. McAuliffe was active in American Mining Congress activities throughout his lifetime and headed many of its coal committees.

Yieldable Arch can be installed as the drift is being driven

These workmen illustrate another special advantage of Bethlehem's yieldable mine roof support: they're installing Yieldable Arch sets right next to the breast of the drift. That means the overburden is brought under immediate permanent control, without the time and expense of temporary roof support.

And we do mean *control*, for as soon as the surrounding forces bear down too hard, the Yieldable Arch will give a little instead of collapsing. This allows the overburden to settle gradually until it forms a natural pressure arch around the mine opening.

The Yieldable Arch works on a sliding joint principle, with friction the determining factor. Nestable segments of U-shaped rolled steel are overlapped at the ends, and these joints are secured with heavy U-bolt clamps which are drawn up tightly enough to hold fast under normal loads. Excessive pressure, however, overcomes the friction in the joint, causing the arch to yield. The load is thus relieved and the structural integrity of the arch is maintained.

Horizontal braces or struts tie one arch set to the succeeding one to provide lateral stability to the structure. Blocking and packing between the lagging and roof are recommended to distribute loads evenly.

Bethlehem engineers have acquired considerable experience in the use, installation and maintenance of Yieldable Arches, and would be glad to apply their experience to your mine-roof problems. A visit to your workings would, of course, be helpful and we would welcome the opportunity whenever it is convenient for you.

BETHLEHEM STEEL COMPANY, BETHLEHEM, PA.

Export Distributor: Bethlehem Steel Export Corporation

BETHLEHEM STEEL

NEWS and views

U.S.B.M. Awards

The Department of the Interior has awarded its highest honors for outstanding Federal service to two administrators of the Bureau of Mines and to a prominent Bureau industry scientist who died recently.

M. J. Ankeny

Interior's Distinguished Service Award and gold medal were bestowed on U.S.B.M. director Marling J. Ankeny and Earle P. Shoub, regional director of the Bureau's Region V. At the same time, a like award was given posthumously to Dr. Irving Hartmann, who, until his death last February, was chief of the Branch of Dust Explosions at the Bureau's Pittsburgh research center.

Director Ankeny's award recognized notable contributions to the advancement of mine safety during 26 years of Government service, in which he rose from first-aid miner to his present position as director.

Lead, Zinc Curtailments Set by American Metal Climax

American Metal Climax, Inc., recently announced reductions in its production of lead and zinc. Jean Vuillequez, vice president, in announcing the action, pointed out that in the company's annual report of 1958 it was stated: "The only lasting cure for the lead and zinc industry here and abroad is to bring supply and demand into balance."

Effective immediately, the company's Mexican lead and zinc production, or its sales of such production to world markets, will be reduced by 6500 short tons of lead and 2000 short tons of zinc on an annual basis. On July 1, the company's production of slab zinc at its Blackwell, Okla., smelter was reduced by about 4000 tons annually.

The announcement by American Metal followed an official release by the United Nations of the proceedings at the Lead-Zinc Committee meeting at which 21 nations were represented. World producers of both metals voluntarily agreed to reduce supplies of lead by 90,000 metric tons annually and zinc by 104,000 metric tons annually in an effort to bring supplies more closely in balance with consumption.

May Make Chemicals from Coal Waste

Philadelphia & Reading Corp. and General Dynamics Corp. have agreed "in principal" to set up a jointly owned $100,000,000 corporation to produce chemicals from anthracite mining wastes and residues.

The new company would be known as Dynamics Reading Chemicals, Inc., and its facilities would be at Pottsville, Pa.—said to be the only area in the country where anthracite mining waste exists in sufficient quantities for an enterprise of this size. The company would produce such chemical products from anthracite waste as ammonia, ammonium nitrate and urea.

Now Shipping Michigan Gypsum

The first shipload of gypsum ore from National Gypsum Company's new northern Michigan mining development arrived at Waukegan, Ill., the first week of May. This constituted the first link-up of National's new $25,000,000 Great Lakes gypsum mining and manufacturing network.

National mines gypsum at its big open pit mine near Tawas City, Mich. The rock is crushed and carried by rail to Lake Huron where it is loaded into ships and transported to Waukegan and, later, to Lorain, Ohio for processing into wallboard, lathe, plaster and other gypsum building products.

New Anthracite-Drainage Project Authorized

Government approval of a new anthracite mine-water-control project in Pennsylvania, designed to protect "hard-coal" reserves totaling over 11,000,000 tons against flooding, has been announced by the U. S. Department of the Interior. Expected to cost about $146,000, in Federal and State funds, the project will involve filling 21 abandoned stripping pits near Olyphant, Pa., with more than 1,000,000 cu yd of dirt and other mine refuse from nearby spoil banks. Connecting with two similar Federal-State water-control works already authorized in Lackawanna County, the new project will help safeguard Hudson Coal Company's Olyphant-Eddy Creek mine, largest single colliery still active in the state's Lackawanna Basin.

Penn State to Host Ninth Annual Drilling Symposium

Exploration Drilling will be the topic of the three-day symposium to be held at Penn State on October 8–10. Jointly sponsored by the Departments of Mining Engineering at the University of Minnesota, Colorado School of Mines, and the Pennsylvania State University, this will be the ninth annual Drilling Symposium held since its inception at Minnesota in 1950. Five technical sessions will deal with statistics and operations research in exploration, bit design and rock penetration, improving core recovery, drilling and sampling of unconsolidated materials, and innovations and case studies in drilling practice.

W. L. Wearly, left, president of Joy Manufacturing Co. and chairman of the Manufacturers Division of American Mining Congress, was recently awarded an honorary Doctor of Engineering degree by Purdue University. Dr. Frederick L. Hovde, Purdue president, conferred the degree on Wearly, who graduated from Purdue with a B.S. degree in electrical engineering in 1937. He joined Joy as a design engineer immediately upon graduation and rose through the ranks to become president in 1957. The degree is the highest honor given by the university in recognition of distinguished achievements by the recipient in the field to which he has devoted his career.

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$750,000 Fire at West Virginia Mine

Preliminary estimates by local fire companies placed damage in the neighborhood of $750,000 in a fire that swept through the screening plant of Tioga Coal Corp., Tioga, W. Va., May 23. The blaze leveled two sections of the tipple operation consisting of crushing, screening and sizing plant and damaged a third, housing a cleaning plant. Cause of the fire has not been determined. Operations resumed June 2 and mine is now operating at full capacity.

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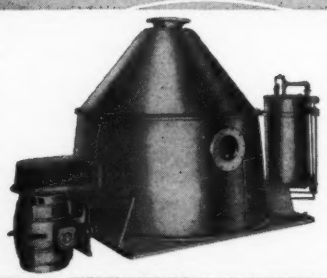

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ALSO . . .

Pierce Management Corp. has concluded a contract with the governments of the United States and Korea as advisory management of Korean government coal mines.

Lehigh Portland Cement Co. will spend $7,500,000 this year to modernize its plant at Alsen, N. Y.

Sale of North American Coal Corporation's coal dock properties to C. Reiss Coal Co., Sheboygan, Wis., was recently announced in a joint statement by Henry G. Schmidt, North American president, and William A. Reiss, Jr., president of Reiss Coal. Involved are a large coal dock in Duluth, Minn., and three coal docks and a briquet plant in Milwaukee. The deal also included a long-term contract for the sale of North American's coal output to the Reiss Co., and a marketing agreement on North Dakota lignite mined by North American.

United States Gypsum Co. has awarded Western-Knapp Engineering Co. a contract to develop an underground gypsum mine at Sperry, Iowa. The contract calls for the sinking of two vertical mine shafts and initial development work at the mining level. It also includes purchase and erection of a headframe on the hoisting shaft, installation of the underground ore pocket, and installation of crushing, mining, ventilating and skip-loading equipment. The mine will be ready for operation December 15, 1959.

One of the world's largest power shovels is now under construction by Marion Power Shovel Co., a division of Universal Marion Corp. James Mullaney, president, revealed in the corporation's annual report to stockholders that the giant machine, a type 5761 stripping shovel, will have a 65-cu yd dipper on a 165-ft boom, and will have a working weight of more than 6,500,000 lb. He added that considerable design work has also been done on a still larger stripping shovel, for which the company hopes to have a firm order shortly.

A new coal-base surface, now in the experimental stage, will be tested on Kentucky roads this summer. The State highway department has agreed to conduct the tests on from 8 to 12 half-mile stretches. Officials of Curtis-Wright Corp., which developed the road building material, recently inspected three sites in Frankfort and one in Lexington for a pilot plant to produce the material. For road-building uses, 2000 to 2200 tons of coal per mile are required. The material is said to be more resistant to moisture than asphalt and can carry heavier loads.

Preparations for exploratory drilling of iron ore deposits in Delta County, Mich., have been started by Cleveland Cliffs Iron Co. Options have been taken on several properties. The exploration is one of many in the central and western upper peninsulas.

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Pattin expansion shells are available and serviced exclusively by Colorado Fuel and Iron Corporation, Denver, Colorado. Western mining companies should contact them direct for information and consultation.

The PATTIN split-type BOLT

The split-type bolt is one of the first slotted bolts, and continues to be a favorite wherever split-type bolts are used. Many mines still prefer this type. The bolt is a full 1-inch in diameter, with cut threads and furnished with hex or square nuts and various size plates and wedges.

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A detailed engineering study on the cost and feasibility of using Pennsylvania anthracite to produce pipeline gas and hydrogen in the United States, made by M. W. Kellogg Co., New York, for the Bureau of Mines, has been made available as an open-file report. The report can be seen at the Interior Department Library, Washington, D. C.; the Division of Anthracite, also Washington; the Bureau's Anthracite Experiment Station at Schuylkill Haven, Pa.; and the Bureau of Mines Library, 4800 Forbes Ave., Pittsburgh, Pa. Persons interested in viewing the document should ask for the report, "Pipeline Gas and Hydrogen from Anthracite Coal—Report No. CE-58-189," by M. W. Kellogg Co.

National Gypsum Co. of Buffalo, N. Y., recently exchanged more than one million shares of stock, valued at some $67,000,000 to acquire Huron Portland Cement Co. Melvin H. Baker, chairman of National, described the acquisition as "an investment in the construction industry's bright future and the favorable prospects for a growing, building America." Huron will continue under the direction of Paul H. Townsend, who has been its president for many years, and will have its own sales force, production units and accounting and research facilities.

U. S. Bureau of Mines recently announced its approval of the multiple short-delay method for blasting coal in underground mines, provided permissible explosives and permissible shot-firing units are used and certain other special precautions are taken. These safety measures are listed in Information Circular 7895, "Special Precautions for Multiple-Short-Delay Blasting in Coal Mines." The publication can be obtained from the Bureau of Mines, Publications-Distribution Section, 4800 Forbes Ave., Pittsburgh 13, Pa.

Christopher Coal Co. has purchased the Bunker Mine of Trotter Coal Co., Monogalia County, W. Va.

William Henry Loveday, who works for the MacGregor mine shop of Amherst Coal Co., at Yolyn, W. Va., has worked nearly 64 years without a lost-time accident. As a result, he has been awarded a Joseph A. Holmes Safety Assn. certificate of honor.

After two years' research and experimentation, the Kyushu Branch of the Natural Resource Technology Laboratory in Japan reports that it has been successful in developing a method of hydraulically transporting coal from the mine face to the surface. A 150-hp centrifugal pump is used to pump coal up to five-in. in size through a six-in. line. It is said that the system has a capacity of 1200 tons of coal per day.

The Kanbayashi Mine, owned by the Nogami Coal Mining Co., working independently, is reported to be using a similar means of coal transportation, and is pumping coal through a 646-meter long pipeline. The later system differs from the one developed by the laboratory in that coal is fed into the high pressure side of the pump instead of the low pressure side.

A coordinated policy on safety standards in mines will be one of the aims of an International Committee for Mining Standards recently established at Essen, Germany. The nine countries represented at the meeting were the United States, Britain, France, East and West Germany, the Netherlands, Belgium, Poland and Sweden.

The Government of Liberia recently announced approval of a plan for development of the Mount Nimba iron ore body by a joint venture of Liberian American-Swedish Minerals Co. (Lamco), and Bethlehem Steel Corp. The property is located about 170 miles inland, and it will be necessary to build a railroad from the mine to the coast at Buchanan where a deep water harbor will be constructed.

Crucible Steel Co. has announced that arrangements have been made to organize a Canadian company to acquire the steelmaking facilities of Sorel Industries, Ltd., at Sorel, Quebec. The new company is expected to produce high speed, tool, stainless and other alloy steel products for Canadian markets and for export.

Chile's El Salvador Mine has produced the first load of copper ore. Scheduled for full production in November, the mine is being developed by the Anaconda Co. through its subsidiary, Andes Copper Mining Co.

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NEWS and views

Montana Coal Development Planned

Montana Power Co. has taken over the vast coal deposits in the Rosebud field of Montana where the Northern Pacific formerly secured its fuel for locomotives operating between Spokane and Dilworth, Minn.

The NP has given the power company a 30-yr lease on 3300 acres of railway coal lands near Colstrip, 100 miles east of Billings. There is reported to be more than 50,000,000 tons of coal remaining which can be recovered by large-scale strip mining.

Montana Power plans to build a steam-electric generating plant augmenting the 66,000-kw steam plant now in operation at Billings. The railroad closed the mine early last year when the NP became fully dieselized.

Miami to Leach Ore in Place

Miami Copper Co. recently announced it would curtail mining operations at its underground properties at Miami, Ariz.

The mine will continue to produce copper, however, by acid leaching its caved-in portions.

Forty employees will be retained to operate a leaching section which is expected to produce 18,000,000 lb of copper per year, compared with the present rate of 25,000,000 lb from the block caving mining method.

ALSO . . .

The Iron King mine of United Park City Mines Co., Park City, Utah, which has been operated successfully as a 300 tpd open pit mine will be converted into an underground mine, it is reported.

Ray Division of Kennecott Copper Corp. will spend approximately $20,000,000 for expansion of its pit and removal of the business district of Ray, Ariz., as part of a $40,000,000 program at its Arizona property. Buildings in adjacent Sonora and Barcelona communities also will be razed as part of the pit project.

John W. Galbreath Development Corp. is building the town of Kearny, Ariz., 12 miles from the mine on a free enterprise basis as a location for businesses removed from corporate property.

The OTHER Shift

I want to tell you boss, I've mined
For twenty years or more;
In all this time I've never seen
A mess like this before.

Just take a look at that air line,
It's broken plumb in half.
You see, the other shift walks out
And then we stand the gaff.

They didn't cover up the hose,
We can't find all the tools.
No one can get away with this!
I guess they think we're fools.

How anyone in eight short hours
Could get so little done!
They really tore the place apart
And never got a ton.

Unless they teach those farmers how
To timber and to drill
I'll turn my pick and shovel in
And go on down the hill.

About the other shift that worked—
What's that?—You're sure you're right?
The Hell you say, how could that be?
There was no shift last night?

Reprinted from *Sharp Bits*, publication of Homestake Mining Co., Lead., S. D.

A permanent record of the operation of an experimental alumina plant by the Bureau of Mines at Laramie, Wyo., is available as *Bulletin 577, Operation of Experimental Plant for Producing Alumina from Anorthosite.* Although the raw material for this plant was anorthosite, an igneous feldspathic rock, the results and conclusions apply in general to other aluminum silicate minerals that are abundant enough to be considered as potential ores of aluminum. The purpose of the experimental program described in the report was to appraise the technologic and economic feasibility of producing aluminum from nonbauxitic ores.

Underground mining operations have been abandoned by Lakeview Mining Co. at its uranium property near Lakeview, Ore. The company has contracted with Isbell Construction Co., of Reno, for open pit mining. Heavy ground conditions were said to be responsible for the change.

Conversion of the Leyden coal mine northwest of Arvada, Colo., into a storage vault for three billion cu ft of natural gas is being studied. If preliminary reports, termed encouraging by Public Service Company of Colorado officials, are supported by later tests, PSC will spend an estimated $5,500,000 in the conversion project. The project would represent the first such use of a coal mine in the world, according to company officials.

A mine in the Enumclaw, Wash., area will be equipped as a radiation shelter for King County residents. Civil defense officials said the upper level of the Franklin mine, three miles from Black Diamond, could accommodate about 3000 persons in the event of an atomic attack. Seattle-King County civil defense director Edward H. Connor said: "There are lots of mines and we look on this as the first step in developing a program that will use them for fall-out protection."

A 1775-ft shaft will be completed at the Christmas copper mine of Inspiration Consolidated Copper Co., about 10 miles north of Winkelman, Ariz. Inspiration's planned production for the Christmas mine is set at 4000 tpd, or 36,000,000 lb of copper annually.

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Eight daily newspapers in six Montana cities were sold recently by Anaconda Co. to Lee Newspapers, a group which publishes ten papers in the midwest. The eight Montana papers have a total circulation of 93,450.

Zinc Industrial, S. A., a new company which will be the first Mexican producer of special high grade zinc, will construct a new refining plant at Tlalnepantla, near Mexico City. Production of the metal, which is used principally for die-casting is scheduled to start in late 1959 or early 1960. Asarco, which owns a 50 percent interest in Zinc Industrial, will provide technical assistance in construction and operation.

An extensive $157,000 two-way radio communications system is being installed by Utah Copper Division, Kennecott Copper Corp., to improve operational efficiency at the mine in Bingham Canyon and related ore haulage operations. Much of the mobile equipment at the mine will be equipped with radio sets operating on two frequencies.

Minimum acceptable grade of uranium ore has been lowered to 0.16 percent from 0.20 percent at Dawn Mining Company's Ford, Wash., uranium processing plant. The move is expected to stimulate uranium activity in the Spokane region.

International Minerals & Chemical Corp. is celebrating an anniversary which marks a half century of expansion and diversification. A traveling display of historical pictures, which will be circulated to various IMC plant locations, recalls mining methods of 1909 and memorabilia of the times—the fashions, the songs, and the heroes of that year.

Incorporated in New York June 14, 1909, the company was originally called International Agricultural Corp. Starting with sales of $5,000,000 annually, it has grown to a nation-wide corporation with 68 mines and plants and annual sales of more than $100,000,000.

IMC has placed major emphasis on research during its 50-year span, always with the goal of better and more economical ways of extracting the earth's ores and of turning them into products for agriculture, industry, and home.

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A $2,000,000 project has been launched at the Moab, Utah, mill of Uranium Reduction Co. The expenditures are for a new alkaline leach circuit which will replace one of two existing acid leach circuits. Installation of the new alkaline circuit utilizing soda ash will result in considerable operating economies by substantially reducing the amount of sulphuric acid used.

New Park Mining Co. "faces the greatest growth period in its history," according to W. H. H. Cranmer, Salt Lake City, president of the company. New Park is now launching an exploration and development project at the Mayflower mine which will cost approximately $800,000. The project is aimed at development of copper prospects in the district.

A new 492-tpd mill will be built by Globe Mining Co. of Casper, Wyo., in the Gas Hills district. The Globe mill will be financed by Union Carbide Corp. and operated through its division, Union Carbide Nuclear Co. Globe is a wholly owned subsidiary of Union Carbide.

Significant progress in developing equipment and techniques for mining western phosphate rock mechanically has been made by engineers of the U. S. Bureau of Mines' Spokane field office. A recent report describes construction and use of the Bureau's second pneumatic vibrating blade planer which incorporates improvements suggested by use of an earlier model.

Plans for a $40,000,000 copper smelter in the Highland Valley area near Ashcroft in South-central British Columbia have been announced by Bethlehem Copper Corp. A subsidiary company, Highland Valley Smelting and Refining Co. has been incorporated in B. C. The decision by Bethlehem directors to form a smelter in addition to a mining division follows what company officials believe to be encouraging results of the exploration of the company's extensive holdings in the Highland Valley copper belt.

A proposed new cement manufacturing plant on Oahu will raise Permanente Cement Company's investment in Hawaii and other islands of the Pacific to $20,000,000. The plant will have an initial annual capacity of 1,700,000 bbl.

Only two men are required to operate the new 400-tpd, $1,500,000 sulfuric acid plant of Kermac Nuclear Fuels Corp., at Grants, N. M. The acid plant is an integral part of Kermac's new uranium mill at Ambrosia Lake. Built by Western-Knapp Engineering Co., the operation is fully automated. A giant electrical control panel in the heart of the plant shows the operators how the many simultaneous operations in the plant are progressing. If trouble arises, the control system sounds an immediate alarm and alerts the operator to the exact nature of the trouble by flashing a light.

Scholarship grants totaling $14,400 are awarded annually by Phelps Dodge Corp. to University of Arizona students at Tucson.

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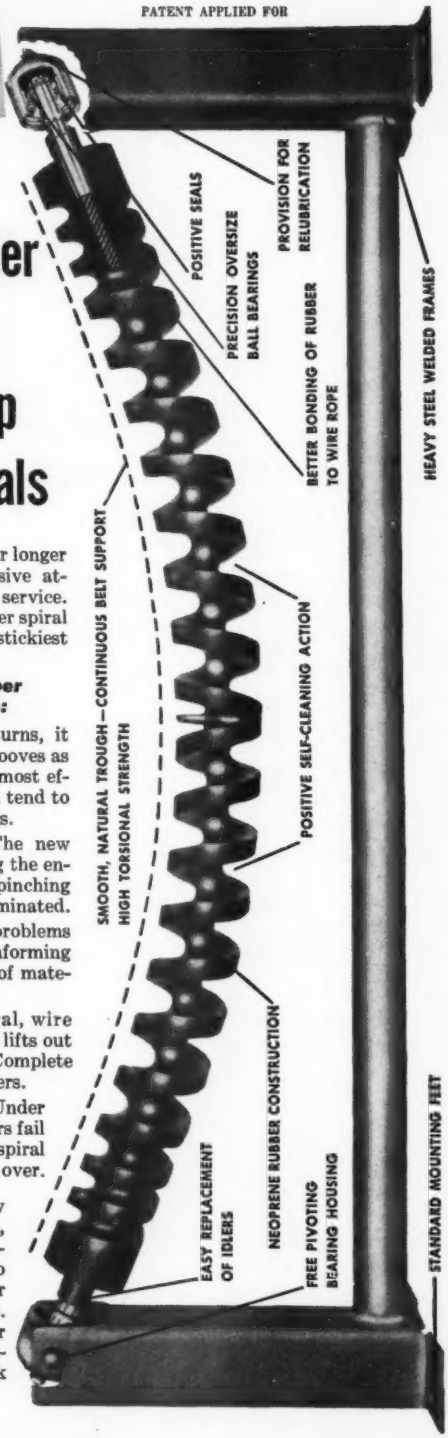
Rubber Spiral Idler lasts far longer, prevents build-up of sticky materials

This new rubber spiral idler lasts far longer than conventional idlers in corrosive atmospheres or exceptionally abrasive service. And its exclusive self-cleaning rubber spiral prevents build-up of even the stickiest materials.

Here are some of the rubber spiral idler's advantages:

- **SELF CLEANING.** As the spiral turns, it "works" any material out of the grooves as they change shape. This action is most effective with sticky materials which tend to build up on common types of idlers.
- **CONTINUOUS BELT SUPPORT.** The new rubber spiral design "moves" along the entire width of the belt; therefore, pinching and sharp bending of the belt are eliminated.
- **SELF TRAINING.** Belt training problems are greatly reduced by readily conforming rubber spiral, and by elimination of material build-up.
- **EASY REPLACEMENT.** The spiral, wire rope, and bearing assembly simply lifts out of its brackets—no tools needed. Complete idler fits standard conveyer stringers.
- **TRUE OPERATING ECONOMY.** Under conditions where conventional idlers fail prematurely, the Hewitt-Robins spiral idler will pay for itself many times over.

Deliveries of this revolutionary new idler are now being made in 18, 24, 30, and 36 inch belt sizes. In addition to the type shown, it is also furnished with a spreader frame for use in wire rope conveyor systems. For further information check your H-R distributor, or write Hewitt-Robins, Stamford, Connecticut. Ask for Bulletin 7-15.



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manufacturers forum

Mine Electrical Safety Device

POSITIVE PROTECTION AGAINST GROUND FAULTS and short circuits on any and all d-c operated off-track mining machines and their trailing cables is now available, according to the Electrical Products Div., of Joy Mfg. Co., manufacturer of a new safety device known as the Lectronic Sentry.

The two-part unit consists of transmitting and receiving elements. Whenever the continuous monitor signal of the sender (attached to mining equipment is interrupted, the receiver (part of automatic circuit breaker at outby end of cable) acts instantly to remove power completely from the trouble-causing machine and/or cable.

Accepted by the U. S. Bureau of Mines for use on permissible equipment, the Lectronic Sentry is said to quickly and safely prevent the energizing of equipment whenever a dangerous condition exists—whether this be a ground fault in the machine itself, a short circuit in the machine or its trailing cable, or a broken or open cable conductor.

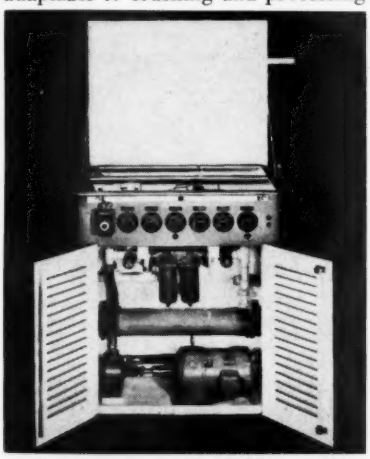
For more detailed information, Bulletin B74 is available from Electrical Products Div., Joy Mfg. Co., 1201 Macklind Ave., St. Louis 10, Mo.

Rubber Lined Vertical Sump Pumps

WITH CAPACITIES FROM 20 TO 1400 GPM, SRL rubber lined vertical sump pumps in sizes from 2 by 2 in. to 6 by 6 in. are now being offered by Denver Equipment Co. They reportedly operate in small spaces on low horsepower without air-locking. The pump has an extremely flat pumping curve which is said to make it ideal for cyclone service. It can handle acids or abrasive pulps, and can operate in sumps as much as 12 ft deep, according to the manufacturer. For further information request Bulletins P9V-B1 and P9V-B2 from Denver Equipment Co., P. O. Box 5268, Denver 17, Colo.

Lubrication Protection Unit

A COMPLETE, PACKAGED LUBRICATING UNIT with built-in safety features, the Symons "Protecto-Lube" System is now being manufactured by Nordberg Mfg. Co., Milwaukee, Wis. Primarily designed for Symons Cone Crushers and available with new units, it is said to be adaptable to crushing and processing equipment now in the field as well as to many other types of mechanical equipment. Lubricant to the equipment is under constant, controllable pressure and temperature and filtered before returning to the oil circulating system.

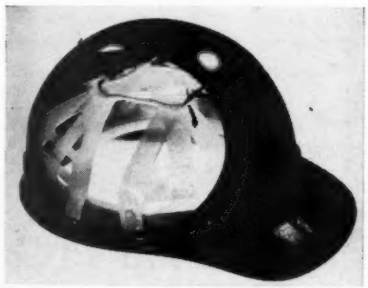


Car Shakers

ADDITION OF A 3½-TON UNIT to its line of car shakers has been announced by Allis-Chalmers Mfg. Co., Milwaukee 1, Wis. The new unit is designed for small and medium operations and is said to be capable of unloading the same materials handled by Allis-Chalmers' five-ton unit except that unloading time will be longer for sticky or frozen materials. The 3½-ton shaker fits all standard hopper-bottom gondolas on North American railroads and is push-button operated, eliminating need for men in or near the car.

Plastic Safety Hats

A LINE OF FIBRE-GLASS, aluminum and electrical (plastic) safety hats and caps has been developed by Apex Safety Products of Cleveland, Ohio, and will be marketed by Boyer-Campbell, safety equipment distributors. Developed for mining, mill and industrial applications, the hat features a polyethylene suspension which includes lock-straps at the peak of the suspension, assuring minimum 1¼ in. clearance between crown and hat shell, while also maintaining adjustment provisions for comfortable crown depth fit. The safety headgear also has a plastic-zippered leather or leatherette sweatband which may be replaced without the need of replacing or disturbing any part of the suspension. Full details are available from Safety Division, Boyer-Campbell, 6540 St. Antoine St., Detroit 2, Mich.



Preparation Screen

REPORTEDLY DESIGNED TO ELIMINATE BLINDING when screening large amounts of "near-opening" size materials, the latest addition to the Wedge-Wire Kleenslot line of screens will be known and marketed as the Taper-Slot.

Basic Wedge-Wire screen construction consists of a series of wedge shaped wires looped, at regular intervals, around a cross-rod positioned at right angles to the wires. Typical distance between loops is 2¾ in. In the Taper-Slot screen, the opening between the wires gradually increases in width between loops. For example, the opening between two wires, from loop to loop, may taper from 0.016–0.024. This combination of opening sizes would be the same between each

wire and loop throughout the entire screen. All tapers or combinations of opening sizes will be custom manufactured for specific applications.

According to Wedge-Wire Corp., Wellington, Ohio, this new design enables materials that would normally lodge between the wires to be transported, with the flow of the mass, to the larger end of the tapered slot. At this point the material either passes thru the screen or becomes loose and continues on with the material flow. In addition, the dip, created by the Wedge-Wire "loop" construction, reportedly will cause the material not falling through the screen to be cleared to pass on to the next section of wire. This increases screening efficiency by eliminating unnecessary "pile up."

Portable Conveyors

THREE NEW UNITS have been added to its line of portable belt conveyors, according to Barber-Greene Co., Aurora, Ill. These conveyors may be used for stockpiling, truck loading, charging hoppers and bins, pouring wet cement, feeding crushers, screens, dryers, and other equipment, and a variety of other applications.

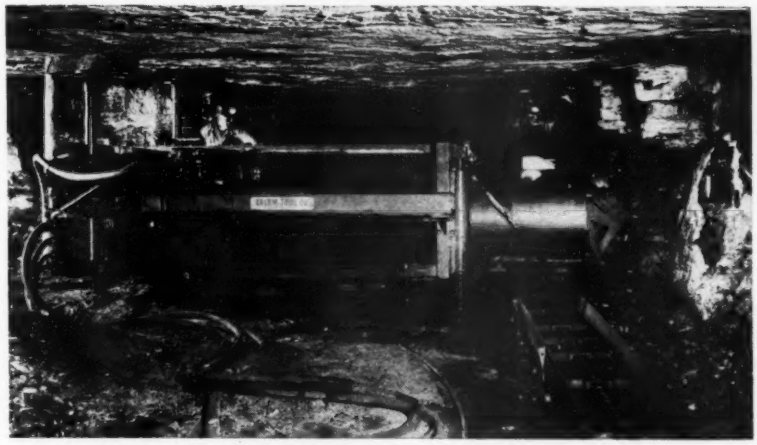
Available in belt widths of 18, 24, 30, and 36 in., and in lengths from 33 to 60 ft in 3-ft increments, the conveyors are offered in three different models, depending upon the type of drive. Model PA-70 has a torque-arm drive powered by an electric motor. Model PB-70 has a V-Belt and countershaft drive powered by a gasoline engine, and Model PC-70 has a line-shaft drive powered by a gasoline engine.

A complete line of feeders, hoppers, and traps is available to allow feeding the conveyor with dozer, crane, dragline, shovel, or front-end loader.

Lubricants

IMPROVED HEAT, ACID AND PRESSURE RESISTANT qualities are being claimed by Lubrication Engineers, Inc., 2709 Race Ave., Fort Worth, Tex., for its line of lubricants known as Almasol products. Two years of field tests have resulted in three major advantages being forwarded for these products: (1) tremendous load carrying strength, (2) resistance to all types of acid wear and (3) ability to retain these important qualities without change up to temperatures of 1900° F. Almasol can loosely and simply be termed an aluminum magnesium silicate, from which components it derives its name.

Underground Coal Recovery Drill



CAPABLE OF HANDLING AUGERS from 24 to 44 in. in diameter and five ft in length, a line of underground coal recovery drills has been announced by Salem Tool Co., Salem, Ohio. The drill and its separate power unit are self-moving on skids and jacks.

Drilling unit for 34-in. augers is 7 ft 10 in. wide, 48 in. high and 11 ft 3 in. long. The cutting head revolves at 33.75 rpm with a forward speed of six fpm. It reportedly is capable of drilling as far as 100 ft.

The separate power unit is connected to the drill with 50-ft hydraulic hoses. The unit is equipped with two 50-hp motors and is available a-c or d-c. It is 6 ft 6 in. wide, 42 in. high and 5 ft 8 in. long.

—ANNOUNCEMENTS—

Allis-Chalmers Mfg. Co. announces appointment of **A. L. Stewart** as engineer-in-charge of crushing, grinding and minerals processing machinery.

Goodman Mfg. Co. has announced the realignment of duties for several key personnel. Elevated to the new position of manager of mining is **C. E. McWhorter** who for many years served as manager of the

C. E. McWhorter

K. E. Caine

company's Denver district, and more recently as mining engineer. Succeeding McWhorter as mining engineer is **K. E. Caine** who has moved to Chicago from his post as manager of the Pittsburgh sales district.

Assuming managership at Pittsburgh is **John C. Cosgrove** formerly district manager at Huntington, W. Va. **L. W. Peterson,** manager of Goodman's Birmingham, Ala., district, has been transferred to Huntington. **Charles D. Reese** succeeds Peterson as Birmingham district manager.

Adrian E. Ross, President of **Sprague & Henwood, Inc.,** Scranton, Pennsylvania recently announced the election of **H. J. Longmore** as Vice-President in Charge of Sales.

Mr. Longmore has been associated with Sprague & Henwood for over 34 years, many of which have been in the capacities of Secretary and Sales Manager. He is well known throughout the diamond core drilling industry, as well as in the mining and construction fields in the United States and abroad. Mr. Longmore is also Executive Vice-President of Sprague & Henwood International Corporation; Vice-President of Mine & Mill Supply Company, and Secretary of Rotary Drilling Equipment Incorporated. These firms are subsidiaries of the parent company, Sprague & Henwood, Incorporated.

(Catalogs & Bulletins—next page)

CATALOGS & BULLETINS

ELECTRIC CAP LAMP. *National Mine Service Co., 2530 Koppers Bldg., Pittsburgh 19, Pa.* Technical bulletin on the Wheat National Model Electric Cap Lamp includes data on design factors which, according to the company, makes possible a 30 per cent increase in light at no increase in weight. Also discussed are such features as fingertip focussing to a perfect spot, improved battery design, and krypton-filled bulb with two full-power identical filaments.

HOW TO SPECIFY PERFORATED METAL SCREENS. *Cross Perforated Metals Plant, National-Standard Co., Carbondale, Pa.* How to specify perforated metal coal and aggregate screens is described in 12 steps in a brochure which covers Cross Hexcreen, Conidure pierced sheets and Rima wedge-shaped-wire screens.

COAL CONVEYOR DATA SHEET. *The Daniels Co., Indiana, Pa.* Data sheet describes the Daniels Type C, fully enclosed and preassembled flight conveyor for coal handling. Built in standardized sections, various combinations of prefabricated sections are said to be adaptable to any length, profile or type of coal handling service.

CONTINUOUS BORERS. *Goodman Manufacturing Co., Halsted St. & 48th Place, Chicago 9, Ill.* Catalog G-141 describes the Goodman line of fixed cutting height continuous borers.

BUILT TO BEAT THE ABC. *Advertising Division, Caterpillar Tractor Co., Peoria, Ill.* Form D862 covers the wearability of Caterpillar track-type tractors in underground mining. Counters to the "ABC"—abrasion, breakdown and cost—are described. Such features as full fuel filtering, heavy duty construction and quality workmanship in Cat equipment are emphasized.

MANVERS CENTRAL COAL PREPARATION PLANT. *Denver Equipment Co., P. O. Box 5268, Denver 17, Colo.* Engineering Notebook, Bulletin No. M4-B100, which describes the Manvers plant, discusses the economic recovery of all coal fines by froth flotation as well as the complete processing of all coal received at this 1320 tph plant. The study analyzes all phases of this large operation, from breaking and sorting to screening and flotation.

ELECTRIC TRUCK CAPACITY. *Exide Industrial Div., Electric Storage Battery Co., Rising Sun and Adams Aves., Philadelphia 20, Pa.* Two bulletins provide a graphic approach to the argument for electric industrial trucks and Exide-Ironclad batteries. Curves measuring and recording performance of a 6,000-lb electric fork truck, with a battery of 500 amp-hr rating, are shown in Bulletin 6226. Ability of lead-battery-powered trucks to get more work done than equivalent trucks with other power sources is documented graphically in Bulletin 6242.

SHUTTLE CAR-TO-BELT FEEDING. *Columbus-McKinnon Chain Corp., Mining Equipment Div., Tonawanda, N. Y.* Bulletin 100 describes the Ratio-Feeder, a method of shuttle-car-to-belt feeding. This unit is a chain and flight conveyor employing two welded link-type chains that converge towards the discharge end. Coal is received from the shuttle car at the car's maximum discharge rate and fed to the belt at a slower, controlled uniform rate.

SIX WHEEL SHUTTLE CAR. *Joy Manufacturing Co., Henry W. Oliver Bldg., Pittsburgh 22, Pa.* A 27-in. high shuttle car with six wheels and a capacity of 4½ tons is described in Bulletin NJ-210. The Joy 18-SC is hinged in the middle to keep all six wheels in contact with the floor, even on rough bottom. Two center wheels drive the car; four end wheels steer. There are no axles, transmissions, or torque converters, and the conveyor runs straight through. The 18-SC is also available in higher and narrower models.

SYNCHRONOUS GENERATORS. *General Electric Co., Schenectady 5, N. Y.* GEA-6815 covers design features, construction and applications of high-speed synchronous generators. Illustrations show manufacturing techniques and typical installations.

WIRE ROPE BENDING FATIGUE. *Advertising Dept., Leschen Wire Rope Div., H. K. Porter Co., Inc., 2727 Hamilton Ave., St. Louis 12, Mo.* Red-Strand Service Bulletin No. 105 explains the importance of the proportion between the diameter of wire rope and the diameter of sheaves and drums on which it runs and describes curbing of losses due to fatigue of wire rope. A table is included showing relative bending life of all major wire rope constructions.

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Herringbone's two pairs of Lang lay strands and one pair of regular lay strands provide the ideal combination of maximum flexibility with good stability.

Finer wires inside contribute to Herringbone's excellent drum-winding characteristics.

Heavier outside wires in each strand have greater resistance to abrasion.

"...and it has a much longer life"

GASKILL CONSTRUCTION COMPANY

The above quote is one of the things that Gaskill Construction Company says about the new Roebling Herringbone* Wire Rope. There are further quotes: ". . . We, after giving your Herringbone cable a great deal of use, find that it is far superior to any other cable and it is much more economical."

These are *user* statements about the newest design development in wire rope in many years. Herringbone is the regular lay and Lang lay wire rope. It is two-ropes-in-one rope, with the best features of each in combination. It has been used, with the same success quoted here, on a wide variety of machines as well as on tough hoisting jobs. Its potential is virtually unlimited wherever all-steel ropes are specified and on most installations where fiber core ropes are standard.

Your Roebling Distributor has full details on Herringbone, or contact Wire Rope Division, John A. Roebling's Sons Corporation, Trenton 2, New Jersey.

*Reg. App. For

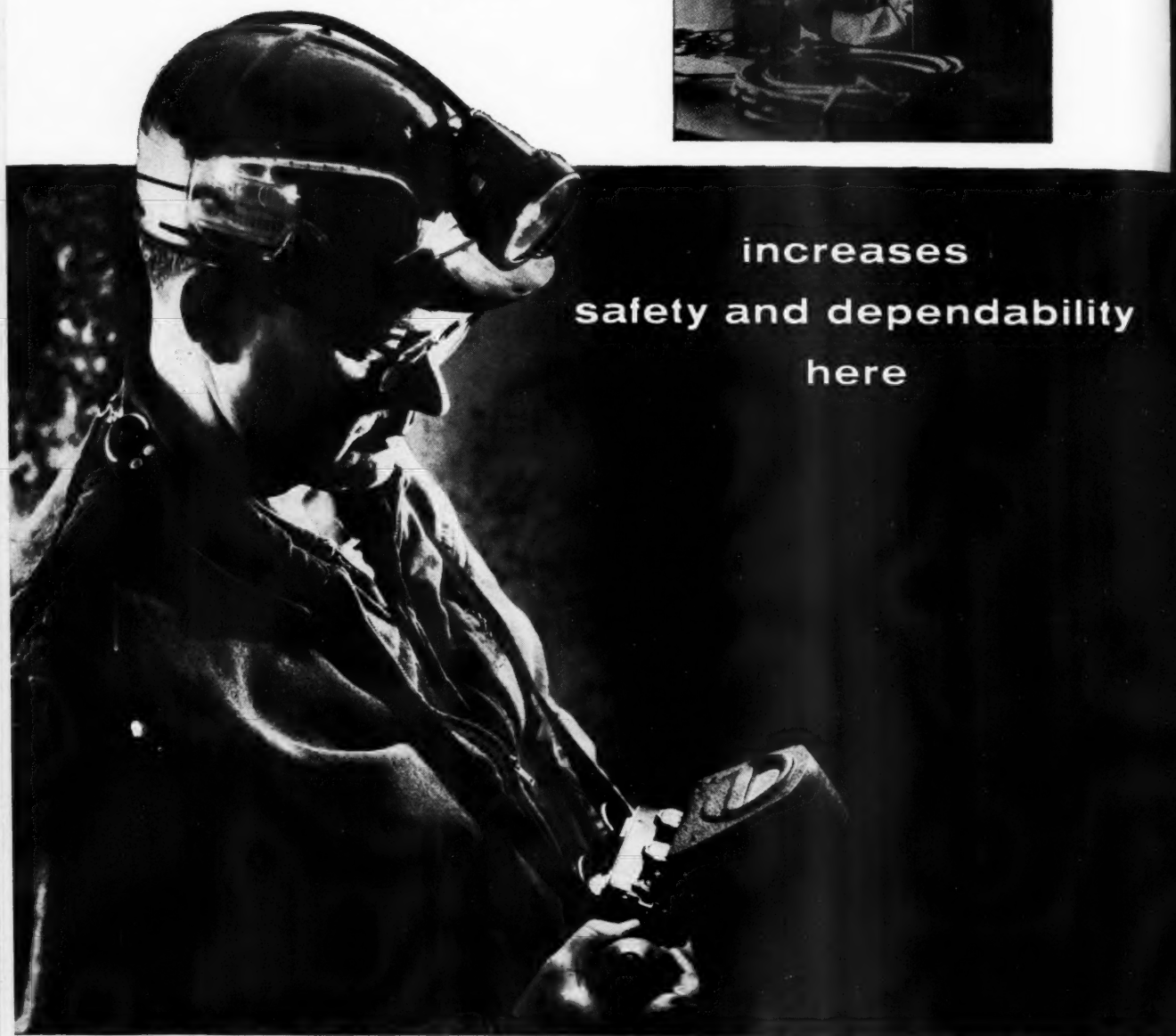
ROEBLING

Branch Offices in Principal Cities
Subsidiary of The Colorado Fuel and Iron Corporation

ROEBLING
HERRINGBONE
WIRE ROPE

A variety of expert skills are tapped to equip MSA instruments with the precision and sensitivity so essential to protecting miners' lives underground.

Built-in quality here →



increases safety and dependability here

Miner squeezes hand-bulb, draws in air sample, and amount of methane registers in seconds on easy-to-read dial of M-S-A Methane Detector Type W-8.

M-S-A® Methane instruments provide working crews with a wide range of safety checks

M-S-A METHANE DETECTOR TYPE W-8 shown above, gives instant, accurate reading of methane. It's light and portable. Has two scale readings for greater accuracy—0 to 2% and 0 to 5%.

M-S-A METHANE TESTER TYPE M-6 is also available. This pocket sized unit indicates methane as low as .2%. It's new, small, streamlined. Edison Electric Cap Lamp battery provides dependable power. Connects and disconnects easily with battery.

M-S-A WOLF JUNIOR FLAME SAFETY LAMP is made of lightweight aluminum. Always a dependable steady flame, guarded by improved ventilation. Easy to read, standard size graduated chimney.

M-S-A METHANE RECORDER continuously charts methane concentrations in return air. Accurate safe check against unusual gas conditions. Serves as guide for regulating volume of air to maintain proper economical ventilation standards.

An MSA representative will be pleased to discuss the safety aspects of these instruments in relation to your operation. Get in touch with him soon or write us for detailed bulletins.

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MINE SAFETY APPLIANCES CO. OF CANADA, LTD.
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